



INSTITUTE FOR DEFENSE ANALYSES

**Proceedings of the NATO Chemical
Human Response
Subject Matter Expert
Review Meeting
21-22 April 2008
Munich, Germany**

Julia K. Burr
Carl A. Curling
Deena S. Disraelly
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Robert A. Zirkle

August 2009
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IDA Document D-3883
Log: H 09-001140



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About This Publication

This work was conducted by the Institute for Defense Analyses (IDA) under contract DASW01-04-C-0003, Task CA-6-2281, "Revision of NATO Planning Guide for the Estimation of Battle Casualties," for the Office of the Surgeon General of the Army. The views, opinions, and findings should not be construed as representing the official position of either the Department of Defense or the sponsoring organization.

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PREFACE

This work was performed by the Institute for Defense Analyses for the United States Army Office of the Surgeon General in partial fulfillment of the task order CA-6-2281 “Review of NATO AMedP-8 *Planning Guide for the Estimation of Battle Casualties*.” On 21-22 April 2008, a meeting was held in Munich, Germany, to reach an international consensus on the chemical agent exposure human response models to be recommended for use in Allied Medical Publication 8, “NATO Planning Guide for the Estimation of CBRN Casualties” (AMedP-8(C)). Attached are the minutes and presentation slides from that meeting which constitute the record of the proceedings of that meeting.

The authors wish to thank the reviewer, Dr. Jeff Grotte for his careful review of this document, and Mr. Lucas LaViolet who edited and produced this document.

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EXECUTIVE SUMMARY

This paper provides a summary of and briefings from the NATO Chemical Human Response Subject Matter Expert Review Conference, held at the Bundeswehr Institute of Microbiology, Munich, Germany in April 2008. The purpose of this two-day conference was to review and amend a casualty estimation methodology for exposure to nerve agents (sarin (GB) and VX) and chemical mustard (HD) proposed by the Institute for Defense Analyses (IDA) for implementation in a revised version of NATO Allied Medical Publication 8 (AMedP-8(C)). The focus of the conference was on the human response component of the methodology, including severity definitions, appropriate dose ranges, and dose-based physiological system symptom progressions and injury profiles for these three agents. During the conference, these elements were discussed and amended to reflect the results of current scientific research and professional opinion expressed by the participants.

This paper begins with a summary of the conference proceedings, followed by the nine briefings presented at the conference. The first three presentations were designed to familiarize the conference attendees with the purpose of AMedP-8(C) and with the proposed general casualty estimation process. The next two briefings described the technical details of the development and content of the methodology's proposed human response component for nerve agents GB and VX, followed by a similar pair of briefings for HD. After these agent-specific briefings, the general casualty estimation and reporting component of the methodology was presented. The final briefing reviewed the consensus points developed by participants during the two days of the conference.

This conference was sponsored by the US Army Office of the Surgeon General (OTSG) in its role as the Custodian of AMedP-8.

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I. NATO CHEMICAL WEAPONS SUBJECT MATTER EXPERT HUMAN RESPONSE REVIEW MEETING PROCEEDINGS

A. Purpose:

The purpose of this meeting was to review the proposed human response model for estimating casualty effects resulting from exposure to nerve agents – sarin (GB) and VX – and chemical mustard (HD), focusing in particular on severity definitions and the dose-based disease profiles for the three agents. The model is proposed for potential implementation in NATO Allied Medical Publication 8 (AMedP-8).

B. Attendees:

Canada

Dr. Thomas Sawyer, Defense Research and Development Canada Suffield
LtCol Ronald Wojtyk, Canadian Forces Health Services Group

Finland

Dr. Tapio Kuitunen, Centre for Military Medicine

France

Dr. Fredric Durandeu, Ministry of Defense (MOD) French Republic

Germany

MAJ Nadine Aurbek, Bundeswehr
Mr. Stefan Hotop, ESG Company Munich
Mr. Jakob Rieck, ESG Company Munich
Dr. Franz Worek, Bundeswehr

Great Britain

Dr. David Bates, UK Surgeon General
Dr. Paul Rice, Dstl Porton Down

Netherlands

Dr. Paul Brasser, The Netherlands Organization (TNO)
Dr. Marijke Valstar, MOD Netherlands
MAJ George Van Leeuwen, MOD Netherlands
Mr. Herman Van Helden, TNO

United States of America

Dr. Carl Curling, Institute for Defense Analyses (IDA)
Ms. Deena Disraelly, IDA

MAJ Kevin Hart, US Army Office of the Surgeon General (OTSG)
LCDR Thomas Herzig, US Navy Bureau of Medicine (BUMED)
COL James Madsen, US Army Medical Research Institute for Chemical Defense
(USAMRICD)
MAJ William Pramenko, J-8, Joint Chiefs of Staff, Joint Requirements Office
(JRO)
Dr. Sharon Reutter-Christy, Edgewood Chemical Biological Center (ECBC)
Dr. Jason Rodriguez, Applied Research Associates (ARA)
LtCol Rich Schoske, USAF
Mr. James Smith, OTSG
Mr. Douglas Sommerville, ECBC
Dr. Robert Zirkle – IDA

C. Meeting Summary:

The following presentations were given:

- MAJ Kevin Hart – Chemical Human Response Review Overview and Objectives
- Dr. Carl Curling – General Human Response Modeling Concept
- Dr. Robert Zirkle – Illustrative Example
- Ms. Deena Disraelly – Nerve Agent Toxicity and Correlation of Dose
- Dr. Robert Zirkle – Nerve Agent Response: Signs and Symptoms Over Time as a Function of Dose
- Ms. Deena Disraelly – Introduction to HD (Mustard) Agent Signs and Symptoms and Equivalent Dose
- Dr. Carl Curling – HD (Mustard) Response: Signs and Symptoms Over Time as a Function of Dose
- Dr. Carl Curling – Chemical Agent Casualty Profiles
- MAJ Kevin Hart – Review, Conclusions, and Way Ahead

D. Areas of Concurrence:

The following areas and topics were concurred on by the Nations during the meeting:

- General modeling concept – human response can be estimated using specified severity levels as occur on disease profiles
 - GB & HD progressions are approved with noted changes
 - VX inhalation progressions follow GB inhalation progressions
 - VX percutaneous liquid progressions will be drawn
- Medical countermeasures and medical treatment are not considered
- Signs and Symptoms levels are descriptive with discussed changes
 - Split ocular and respiratory signs and symptoms to represent GB/VX and HD separately
 - Incorporate GB/VX cognitive changes to the Neurological System Progression Map and incorporate seizures and prolonged seizures

- Change the order of HD skin temporal description in “very severe” category
- Proposed toxicity values and resultant dosage ranges are accepted as shown in Tables 1-5.
- Further investigation of GB miosis effective median toxicity value may be required
- Resulting dosage ranges are acceptable with changes to descriptions as discussed
 - Change “Mild Respiratory Effects” to “Rhinorrhea” change “mild resp. symptoms:” in lowest dosage range for both nerve agents
 - Add “Shock-like syndrome” to Respiratory dosage range 8 for HD
- Recommended values for severity & time associated with Killed in Action (KIA), Wounded in Action (WIA) & Died of Wounds (DOW) are accepted as shown

Table 1. Inhaled GB Dosage Ranges

GB Equivalent Dosage Range	Description
< 0.2	No observable effect in majority of population
0.2 – < 1	Miosis in 10% – 90%, rhinorrhea, transient tightness of the chest
1 – < 6.5	Rhinorrhea, dimmed vision, mild headache, excessive airway secretions induce cough, maximal ocular disease
6.5 – < 12	Runny nose, dim vision or eye pain with sensitivity to light, nausea, frequent cough
12 – < 25	Maximal secretions and eye effects, vomiting, abdominal cramps, severe headache with anxiety and confusion, tight chest, convulsions, severe effects in 10% – 50%
25 – < 30	Twitching, weakness, diarrhea, convulsions progressing to collapse and respiratory failure, lethality in 10%
≥ 30	Collapse and respiratory failure, severe effects in 90%, lethality in ≥ 50%

Table 2. Inhaled VX Dosage Ranges

VX Equivalent Dosage Range	Description
< 0.02	No observable effect in majority of population
0.02 – < 0.3	Miosis in 10% – 90%; rhinorrhea; transient tightness of the chest
0.3 – < 2	Rhinorrhea; dimmed vision; mild headache; excessive airway secretions induce cough; maximal ocular disease
2 – < 4	Runny nose; dim vision or eye pain with sensitivity to light; nausea; frequent cough
4 – < 10	Maximal secretions and eye effects; vomiting; abdominal cramps; severe headache with anxiety and confusion; tight chest; convulsions; severe effects in 10% – 50%
10 – < 13	Twitching; weakness; diarrhea; convulsions progressing to collapse and respiratory failure; lethality in 10%
≥ 13	Collapse and respiratory failure; severe effects in 90%; lethality in ≥ 50%

Table 3. Ocular HD Dosage Ranges

HD Dosage Range (mg-min/m³)	Description
0 - 4	No observable effect.
4 - 26 26 - 50	Eyes sting, tears, blurred vision; 10% have mild ocular effects at 9 mg-min/ m ³ ; 50% at 25 mg-min/m ³ ; 10% have severe ocular effects at 28 mg-min/ m ³ .
50 - 70	Eyes feel gritty and sensitive to light, non-stop tears flood eyes; 90% have mild ocular effects at 67 mg-min/m ³ .
70 -100	Eyelids are puffy, and eyes burn; eyes are too painful to keep open; 50% have severe ocular effects at 75 mg-min/m ³ .
> 100	Eyelids are swollen shut and burning, eyes are too painful to open; 90% have severe ocular effects at 200 mg-min/m ³ .

Table 4. Inhaled Vapor HD Dosage Ranges

HD Dosage Range (mg-min/m³)	Description
0 – 50	No injury.
50 – 70	Nauseated, swallows often.
70 – 100	Dry mouth, dry cough, sneezing, runny nose, headache, nauseated, vomited once or twice; 10% have severe effects at 80 mg-min/m ³ .
100 - 150	Sore throat, continuous cough, hoarseness, chest feels tight, headache, fever; 50% have severe effects at 135 mg-min/m ³ .
150 - 250	Hurts to breathe, hacking cough, cannot speak, headache, dry heaves, fatigued from vomiting; 90% have severe effects at 230 mg-min/m ³ .
250 - 1200	Awful chest pain, wheezing and shortness of breath, coughs up red colored mucous; 10% die at 600 mg-min/m ³ and 50% mortality at 1000 mg-min/m ³ .
>1200	Very severe effects; 90% mortality at 1700 mg-min/m ³ .
Dosage Range (mg/man)	Description
> 1400	Very severe effects, including bone marrow suppression due to liquid dosage; >50% lethal effects at 1400 mg/man.

Table 5. Equivalent Percutaneous HD Dosage Ranges

HD Equivalent Dosage Range (mg-min/m³)	Description
0 - 12	No observable effect.
12 - 125	Skin sensitive to touch in tender areas (crotch, armpits, inside of elbow and knee); threshold effects in 10% at 19 mg-min/m ³ , in 50% at 50 mg-min/m ³ .
125 - 180	Skin sore in tender areas; painful when moving; red body skin; tiny blisters on hands and neck; 90% have threshold effects at 134 mg-min/m ³ .
180 - 300	Skin raw and painful tender areas; red, swollen body skin; large blisters on hands and neck; 10% have severe effects at 187 mg-min/m ³ .
300 -1800	Skin peels off leaving open raw areas and painful ulcers in tender areas; 50% have severe body skin effects at 500 mg-min/m ³ ; 90% at 1337 mg-min/m ³ .
1800 - 12000	10% die at 6560 mg-min/m ³ exposure over whole body; 50% die at 10,000 mg-min/m ³ exposure over whole body.
> 12000	90% die at 15,243 mg-min/m ³ exposure over whole body.

E. Recommendations/Next Actions:

Based on this meeting, the following additional tasks were recommended:

- For the Nations – provide supporting documentation, studies, & references as available, specifically to include information regarding:
 - Toxicity values and probit slopes
 - Signs & symptoms progressions
- For the US –
 - Add a note to the definition of WIA to include the duration of time (i.e. note that the definition of WIA does not account for cancer)
 - Propose VX percutaneous liquid maps for review by the Nations
 - Change GB/VX inhalation maps and HD maps as discussed
 - Change signs & symptoms descriptions as discussed
 - Change dosage range descriptions as discussed
 - Verify the 30-300 minute exposure for HD with SMEs and clarify in the assumptions
 - Note several topics as model limitations and address in the text of SD.3:
 - Cardiovascular effects resulting from nerve agent exposure are not addressed in the methodology
 - Hematopoietic syndrome effects resulting from HD exposure are not addressed in the methodology

- Signs & symptoms descriptions reflect the ascension of illness; recovery phase of illness is not explicitly described

F. Meeting Notes: Presentations were given by MAJ Hart, Dr. Curling, Ms. Disraelly, and Dr. Zirkle.

1. MAJ Kevin Hart – Chemical Human Response Review Overview and Objectives

MAJ Hart began by outlining the meeting objectives, then briefly outlined the casualty estimation concept and discussed the foundations of NATO's casualty estimation methodologies. The starting point of the human response model follows the outputs described in SD.2 – that describes what we need out of the dispersion model – where the people are, how many, their disposition, the concentration and doses they are exposed to.

He discussed the development process and the potential process for implementation. He anticipated that for NATO planning purposes, there would be a requirement to work with the people currently working on SABERS or MEDIC to build an implementation capability.

The stated purpose of the document is for medical planners to get to what information they need: medical casualties and battlefield effects, resources, etc. If other things fall out, then all the better, but really the end-state customer is the medical planner.

He closed by reviewing the meeting agenda.

Questions by participants included:

- Who will review the documents?
 - o Nationally, the US medical planners will look at it; MAJ Hart anticipated that it would be similar for other Nations. ACO and ACT will also review.

2. Dr. Carl Curling – General Human Response Modeling Concept

Dr. Curling laid out the foundation for the remainder of the meeting, describing the development of the AMedP-8 SD.3 document, the general human response modeling concept proposed for use in the document, definitions, assumptions, and model limitations. The proposed human response models are described by injury profile maps – based on an explanation of symptoms severities over time, which are combined to build a injury progression map. The objective of the document is to estimate the status over time of some personnel exposed to some CBRN agent. To focus on chem., it is the number of people who are expected to be wounded or killed as a result of agent or effect.

The model does not look at certain medical casualties – those who are psychological casualties although they may be expected to seek medical assistance or those who are died or injured as a result of secondary injuries.

MAJ Hart pointed out that some of the feedback at the end of the last AMedP-8 process included a lack of knowledge about where the information came from. One of the goals of this document is to document where values came from, where the information is derived from, and how the definitions and methodology are created.

Questions by participants included:

- Is the thirty minute boundary for KIA applicable to chemical agents or all agents?
 - o It is not a fixed number, but rather a standardized recommendation.
- Will the model be robust enough to allow changing the time periods associated with KIA?
 - o For simplicity, the timeline starts from the release of the agent, and that may be obvious for some agents and attacks but not for others. KIA is a flexible definition. Although 30 minutes is used in the examples, it can be changed by the user.
- Does the human response model take into account whether individuals are carrying effective antidotes?
 - o Medical countermeasures are not taken into account because there is limited information on how they would change human response. Further, the CBRNMedWG agreed in last meeting to not include medical treatment because we don't have the information and because every nation is different.
- Within a dose range, why not allow for a sliding scale?
 - o The objective is to not have an infinite number of disease profiles; to simplify the model into a limited number of profiles that can describe the overall systemic reaction.
- Injury maps seem to indicate spontaneous recovery. Is this not calculated?
 - o Because medical treatment is not considered, an estimation of recovery time is not a useful value as it is expected that with medical treatment, the individual would recover faster.
- Why are these the only agents considered?
 - o This is what the information is available for; additional agents could be added later since the process and required information will be defined through the current process
- Is the model a dynamic one? For example, if it's a 70 minute exposure, could you update the casualty estimate?
 - o The model can be updated dynamically; the potential is there to be dynamic. The actual implementation may not be there depending on modeling capability.
- Are secondary infections, burns included in HD?
 - o Septic pneumonia and skin burns are included, but secondary infection of the burns is not included.
- Why not look at secondary effects of nerve agent respiratory which occur with intensive care?

- If the icon requires intensive care for respiratory, they are assumed to be expectant; we don't model much beyond 30 minutes. HD respiratory effects due to percutaneous exposure was added as a result of input from US SMEs because they felt it was important to include.
- Are you discriminating, having a battalion in defense and a battalion in attack? Difference in susceptibility and breathing rate?
 - Those factors are considered as described in SD.2; the dispersion model and protection and dosage are determined in SD.2. I can account for that prior to this in the exposure of individuals. In this human response model, we are assuming you got exposed to a certain amount and however you got exposed is how you got exposed.
- Are you still working with the previous scenarios?
 - These are not scenario dependent, although at some point, we may need to agree on scenarios for inclusion in SABERS.

3. Dr. Robert Zirkle – Illustrative Example

Dr. Zirkle walked through an illustrative example, describing the series of clinically differentiable dosage bands, each of which has signs/symptoms dosage maps associated with it, as well as the injury profile map which gives an overall example of how disease severity changes over time. Further, there are criteria set by the user which describe the personnel status and the times under consideration – i.e. time to reach a medical treatment facility, evaluative time period, reporting time, total time, etc. The inputs are exposures, and the estimation of casualties follows a process to determine KIA, WIA, and DOW as applicable. Additionally, he walked through a number of specific examples to demonstrate how the model works.

Questions by participants included:

- Do you report out with confidence intervals?
 - We may be able to have confidence levels around multiple scenarios; but cannot have confidence levels around a single scenario
- How does the planner get the information to make the right assumptions in the model?
 - We hope that the part of the process is the recommended values.
- How will the user know why/when model inputs/parameters should change?
 - There are a number of ways it could be done – lookup table to computer interface; the more sophisticated the model, the more sophisticated the user has to be. It depends on the training of the user; if not sophisticated, then recommend using the existing values.
 - Further, part of the new AMedP-8 is that there is an agreement on the methodology, but the national implementation – or how you want to use it – whether you use a tool or the methodology, is up to the nations. The question is whether the methodology your nation is going to use is a standard methodology.

- Did you do a study into comparison to other models?
 - o Not yet; before we do that we'd like to make sure that our human response model is correct; then we would expect to have some comparison.
- How reliable is the model?
 - o The best that we can do is test the verification of the model and the validation of the model. The validation question is it scientifically accepted? And there are a variety of ways to test this. The second question is do you get out what you think you'll get out? Both of these will be evaluated before it's published as a ratification draft. Part of what we're trying to answer now is, is it scientifically valid?

4. Ms. Deena Disraelly – Nerve Agent Toxicity and Correlation of Dose

Ms. Disraelly talked about the proposed toxicity values for nerve agent and the dosage bands, as well as the equivalent dosage calculations. The proposed toxicity values come from FM 3-11.9; these values were presented last year at the Dutch NATO meeting [actually Grotte-Yang numbers, but differed by one value] and accepted.

Questions asked by participants include:

- Why did slopes change in the GB toxicity values?
 - o These are the values as shown in FM3-11.9.
- What was used in developing the FM 3-11.9 values: human or animal studies?
 - o Mostly animal studies, but FM 3-11.9 based on meta-analysis of all available studies.
- What is meant by the term “mild respiratory symptoms”?
 - o Rhinorrhea; will change “mild resp. symptoms:” to Rhinorrhea in .2-1mg
- What is meant by 10-90% ocular disease?
 - o Mild ocular effects; participants agreed that these symptoms are not expected to manifest below 2mg-min/m³ (vice 0.4 mg-min/m³)
- Why are you using a 2-minute exposure?
 - o The maps are based on a 2-minute exposure.
- Are the perc liquid values for whole body or partial exposure?
 - o Whole body; it would be erroneous to assume partial body, given study data.

Participants expressed concern that the presented values do not include confidence level values for toxicity data such as found in FM 3-11. They were not included because they are not included in the output to the model. Additional modeling is being done and can be incorporated later.

Participants also recommended the development of percutaneous VX maps (to replace the equivalent dosage calculation). Participants agreed that VX vapor could be disregarded; more data exists to support the derivation of VX percutaneous liquid maps.

5. Dr. Robert Zirkle – Nerve Agent Response: Signs and Symptoms Over Time as a Function of Dose

Dr. Zirkle reviewed the model assumptions and then presented the symptoms, as well as the symptoms progressions and overall injury profiles over time for the chemical nerve agent GB. The symptoms progressions and overall injury profiles for inhaled VX will remain similar to those presented for GB; as recommended by the participants, the percutaneous VX liquid symptoms progressions and injury profiles will have to be added at a later date (the proposed maps drawn with the assistance of USAMRICD are shown at the end of this document).

Questions asked by participants include:

- Participants asked about the inclusion of recoverable casualties.
 - o Participants were reminded that previously the CBRNMedWG had agreed to drop recoverable casualties.
- Participants asked why temperature was not included, indicating that vapor might not be expected for VX?
 - o MAJ Hart recommended the development of VX percutaneous liquid maps within the US and circulated to the Nations for comment.

Participants again raised the issue of miosis effects. The suggestion was that Nations review their data and provide applicable information for consideration.

Participants also discussed Haber's Law and the Mijoushevski Data.

Participants recommended running the previous AMedP-8 values and estimate the differences resulting from casualty estimation using the two methodologies. MAJ Hart pointed out that sensitivity analysis will take time; it may be possible at a later time.

Participants recommended changing "ocular disease" to "miosis" in the dosage ranges descriptions.

Participants recommended dropping the word "vapor" and describing VX effects solely as "inhaled VX" as a function of both vapor and small liquid particles.

Participants also discussed the applicability of inhaled GB progression maps for inhaled VX; participants suggested that onset may be slower, but there is very little data to support changes.

6. Ms. Deena Disraelly – Introduction to HD (Mustard) Agent Signs and Symptoms and Equivalent Dose; and Dr. Carl Curling – HD (Mustard) Response: Signs and Symptoms Over Time as a Function of Dose

Ms. Disraelly introduced the HD chemical warfare agent dosage ranges for ocular, respiratory/upper gastrointestinal (GI) tract, and skin effects and described the derivation of the

ranges. Dr. Curling continued the discussion addressing the signs and symptoms for the specified physiological systems and the associated human response signs and symptoms progression maps and injury profile maps.

Questions asked by participants included:

- When does septicemic pneumonia occur?
 - o Approximately 1 to 3 weeks post exposure
- What is the basis for increasing the dosage ranges from those used previously?
 - o The basis is the probit values included in FM 3-11.9
- There is potential for bone marrow suppression to lead to systemic effects but also for the same to occur with skin burns. Why isn't this included?
 - o Septicemic pneumonia is different from the burn-induced systemic effect – this results from agent absorbed through the skin versus the effects on the respiratory system.
- Why are hematopoietic effects not included?
 - o Researchers were not able to find data; the physiological effects could be included if data were available.
- Most nations have “life, limb, and eye” for triage. Why does the ocular system severity table not include a level 4?
 - o The ocular system does not endanger life.
- Why isn't a severity level 4 considered for skin?
 - o The skin burns themselves, while they may cause a systemic and immune system failure, are not lethal themselves.

Participants agreed that calculating equivalent dosage for liquid and vapor is a reasonable assumption for HD as both liquid and vapor HD exposures lead to similar systemic effects.

Participants suggested that systemic poisoning was seen 1 to 2 weeks post-exposure in the Iranian patients.

Participants discussed the ocular system severity descriptions and suggested “irritation with eye pain; conjunctival erythema and/or edema” in Severity 1. Participants also recommended removing “blurred vision due to...” For severity level 2, participants recommended “eye pain and/or irritation with conjunctival erythema and/or edema; blepharospasm; difficulty opening the eyes; sensitivity to light.” For level 3, participants recommended “severe eye inflammation and pain leading to an inability to open the eyes.”

Participants recommended putting “skin sloughage after blisters or swollen skin;” they suggested that the temporal order was wrong. As a result of the sloughage, the burns become raw and painful.

Participants recommended changing respiratory symptom severity level 3 to include “severe dyspnea or severe trouble breathing.”

Participants discussed the symptom progression maps, concentrating specifically on the latent periods associated with specific dosage ranges.

Participants recommended the termination of symptoms after the individual would be expected to have become DOW rather than having the progressions carried out further.

Participants suggested that the progression for healing is not the same as the progression for injury and further suggested making a notation in the text regarding the signs and symptoms reflecting the ascension phase (but not the recovery phase of the injury).

Participants recommended the collapsing of equivalent skin dosage ranges 180 and up; they did not believe that the skin would get worse than that. Participants argued against the complexity of adding a specific map to account for septicemic pneumonia for three reasons: 1) complexity of the map; 2) not a skin effect; 3) this is vapor through the skin. Participants argued over whether the effect was respiratory or skin related. The final recommendation was to annotate in the text that there is some radiomimetic syndrome and capture a septicemic pneumonia map.

7. Dr. Carl Curling – Chemical Agent Casualty Profiles

Dr. Curling presented the methodology for using injury profile maps to estimate casualties and other personnel status and discussed multiple levels of detail that could be considered. He recommended the specification of casualties by insult (i.e. chemical nerve agent or chemical blister agent) and severity level at time of casualty presentation.

Participants recommended the severity level for WIA be set at 1 or “mild.”

Participants further recommended annotating the 30 minutes to seek medical treatment in the assumptions section and the group concurred with the proposals for KIA and DOW casualty estimation.

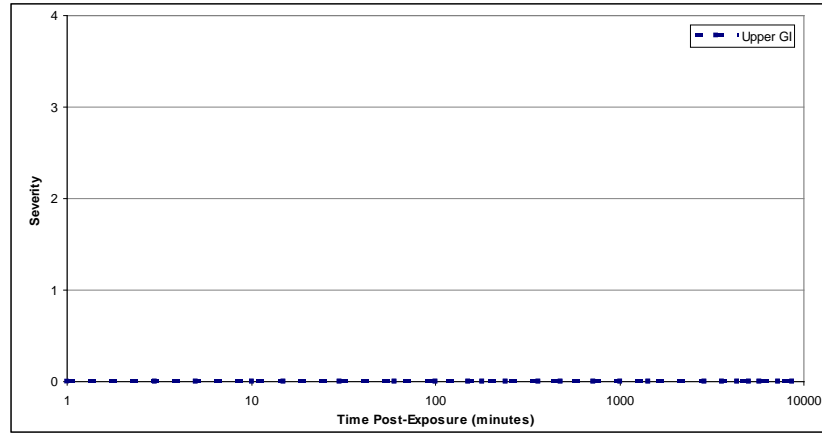
8. MAJ Kevin Hart – Review, Conclusions, and Way Ahead

MAJ Hart concluded the meeting by thanking participants and reviewing the areas of concurrence and taskings. (The areas of concurrence and the taskings are listed earlier in this document.) The symptom progression maps and injury profiles, as agreed upon by consensus of the SMEs at this meeting, are presented in Figures 1-32.

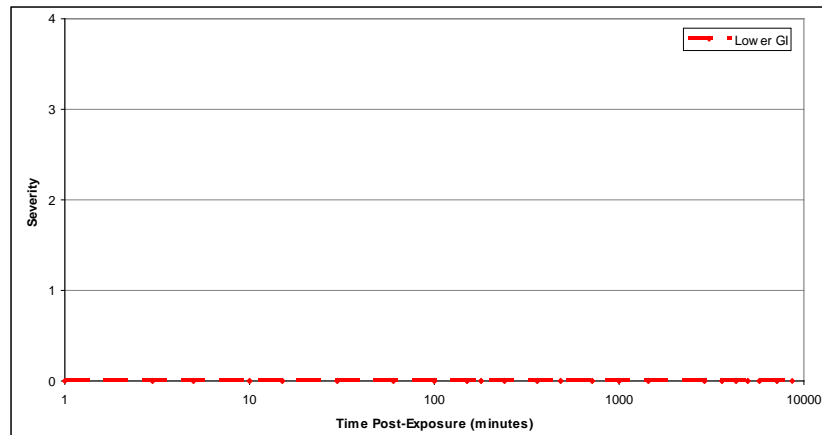
Questions from the participants included:

- I thought that we had decided we would add “rhinorrhea, transient tightness of the chest?”
 - o These descriptions were added for chemical nerve agents.

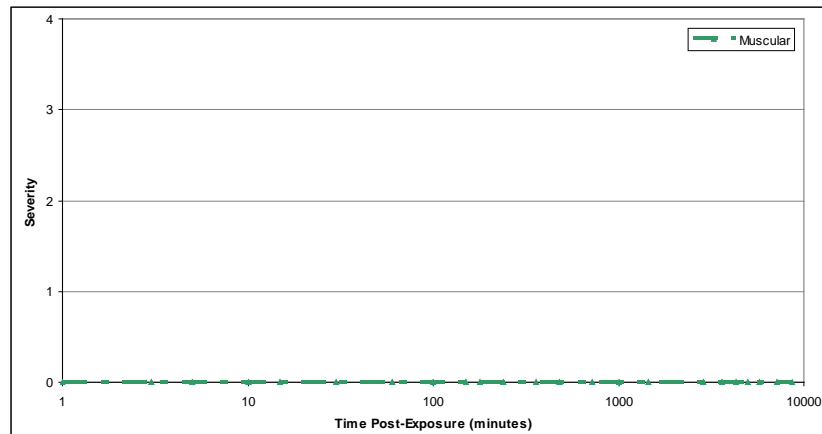
- Do we have rhinorrhea associated with HD?
 - o No.
- Where is validation of the model in this schedule?
 - o It's not. Part of that process is that you look at a particular model that's been developed and that model that's been described scientifically sound, etc. I don't have a plan to go and validate this process, per say. Our validation is in the plan. But there is no mechanism to validate a standardization model...there's no requirement to do it.
- What is the appropriate route for feeding back information?
 - o MAJ Hart recommended that information and feedback be passed to him or passed through the website.



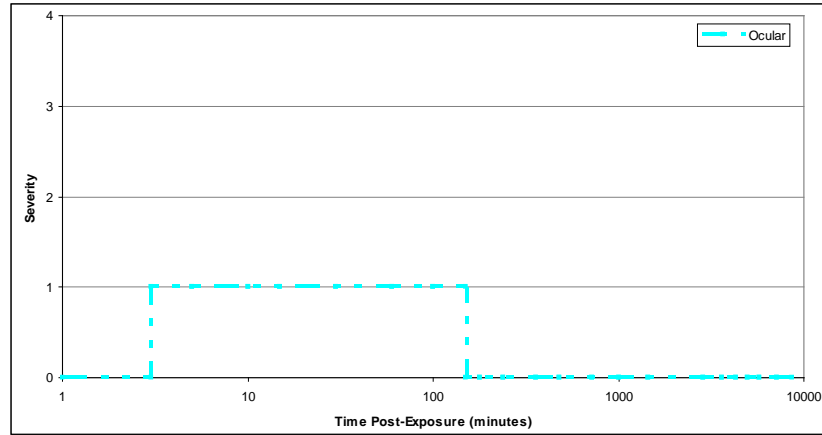
**Figure 1. Upper GI Symptom Progression for Inhaled GB Vapor
Dosage Range $0.2 - < 1 \text{ mg-min/m}^3$**



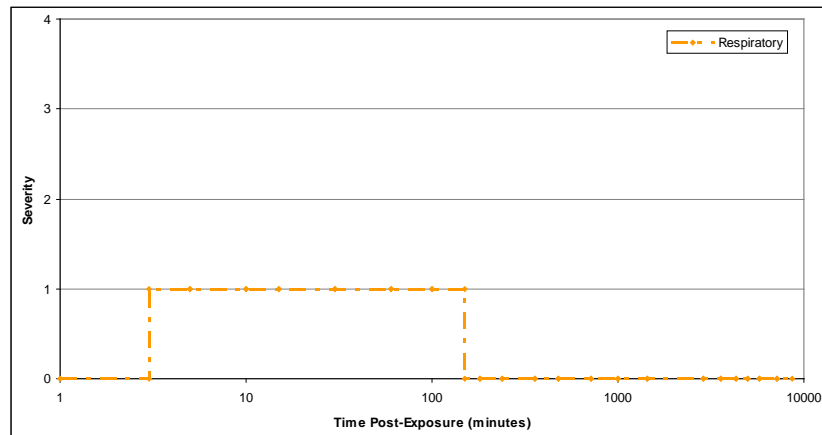
**Figure 2. Lower GI Symptom Progression for Inhaled GB Vapor
Dosage Range $0.2 - < 1 \text{ mg-min/m}^3$**



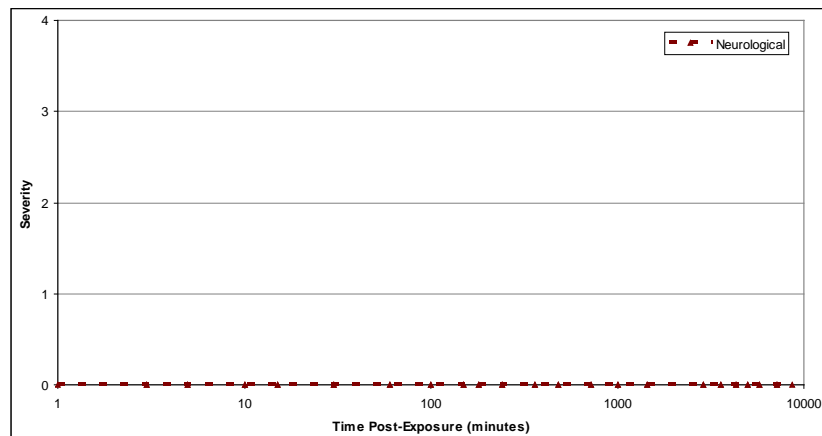
**Figure 3. Muscular Symptom Progression for Inhaled GB Vapor
Dosage Range $0.2 - < 1 \text{ mg-min/m}^3$**



**Figure 4. Ocular Symptom Progression for Inhaled GB Vapor
Dosage Range 0.2 – < 1 mg-min/m³**



**Figure 5. Respiratory Symptom Progression for Inhaled GB Vapor
Dosage Range 0.2 – < 1 mg-min/m³**



**Figure 6. Neurological Symptom Progression for Inhaled GB Vapor
Dosage Range 0.2 – < 1 mg-min/m³**

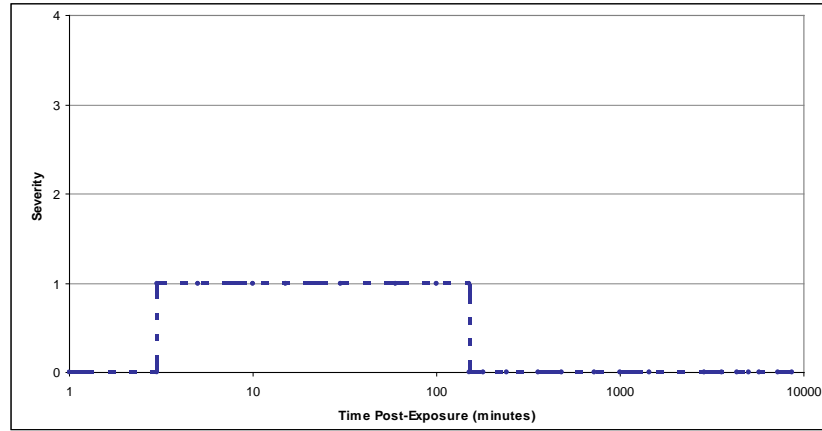
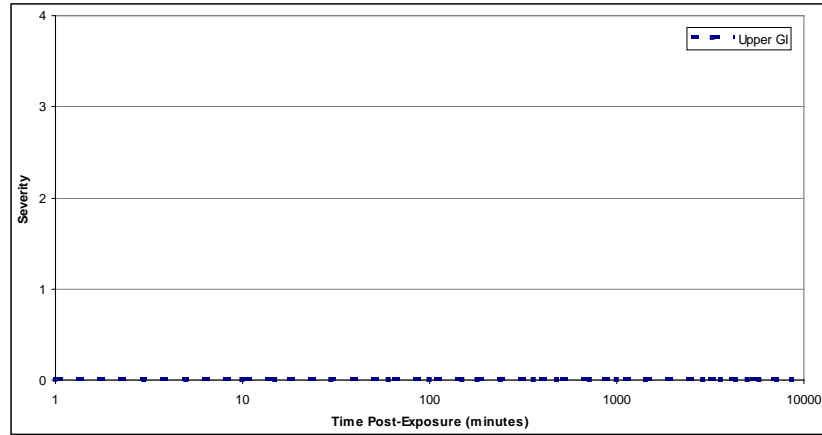
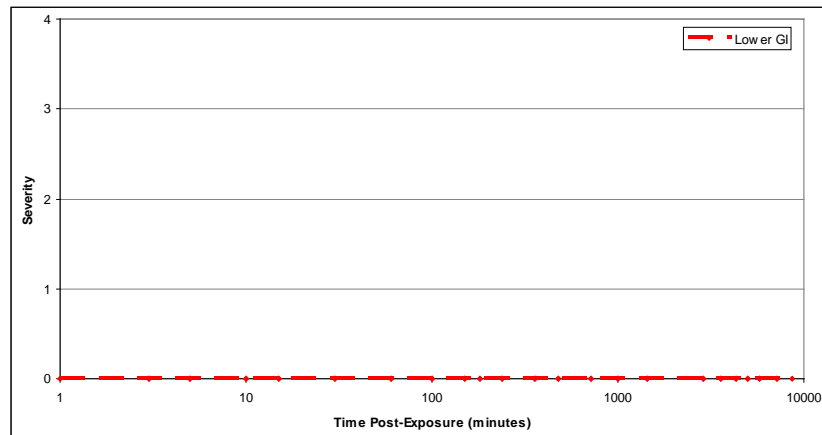


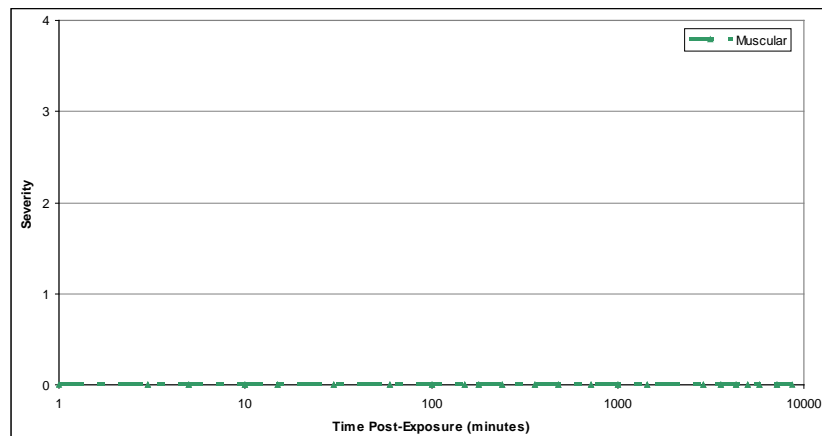
Figure 7. Injury Profile for Inhaled GB Vapor
Dosage Range 0.2 – < 1 mg-min/m³



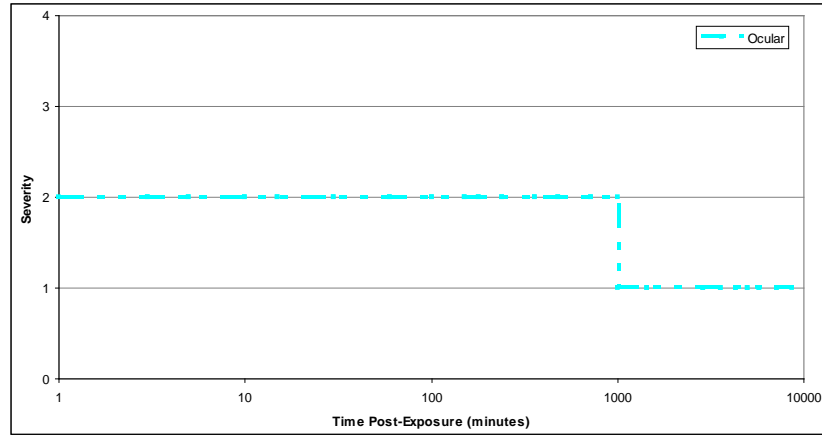
**Figure 8. Upper GI Symptom Progression for Inhaled GB Vapor
Dosage Range 1 – $< 6.5 \text{ mg-min/m}^3$**



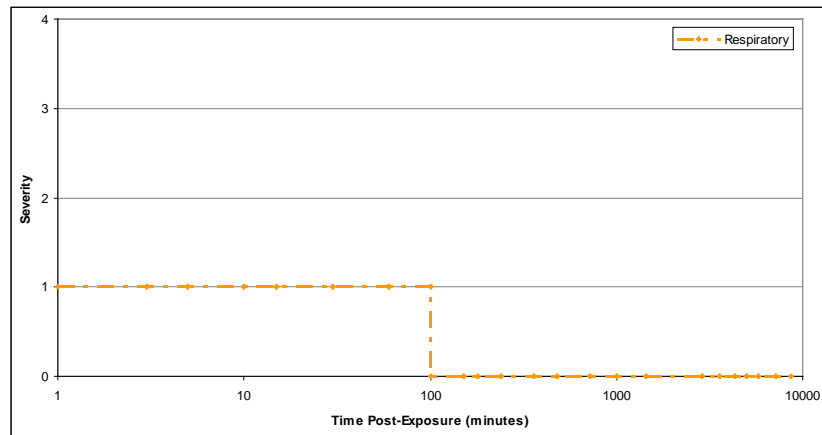
**Figure 9. Lower GI Symptom Progression for Inhaled GB Vapor
Dosage Range 1 – $< 6.5 \text{ mg-min/m}^3$**



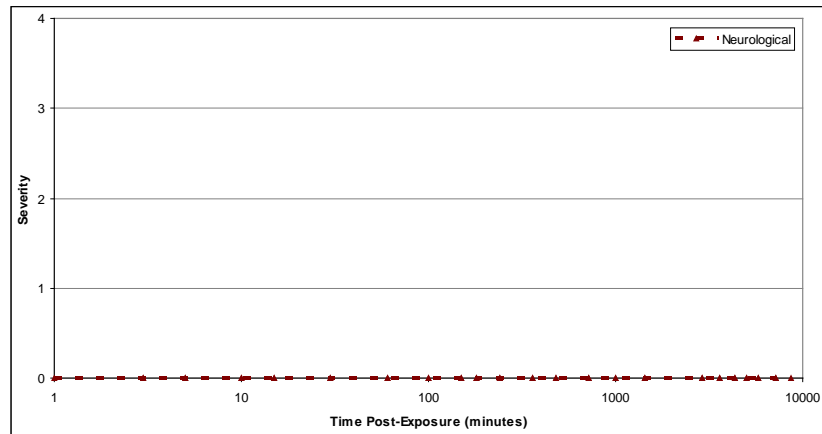
**Figure 10. Muscular Symptom Progression for Inhaled GB Vapor
Dosage Range 1 – $< 6.5 \text{ mg-min/m}^3$**



**Figure 11. Ocular Symptom Progression for Inhaled GB Vapor
Dosage Range 1 – $< 6.5 \text{ mg-min/m}^3$**



**Figure 12. Respiratory Symptom Progression for Inhaled GB Vapor
Dosage Range 1 – $< 6.5 \text{ mg-min/m}^3$**



**Figure 13. Neurological Symptom Progression for Inhaled GB Vapor
Dosage Range 1 – $< 6.5 \text{ mg-min/m}^3$**

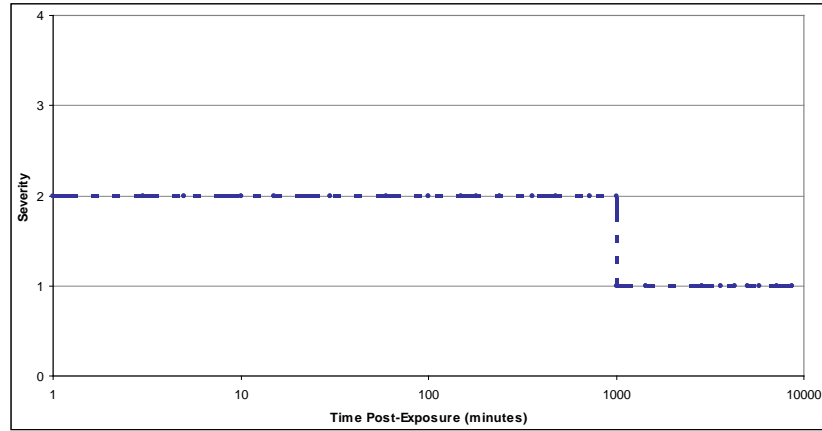
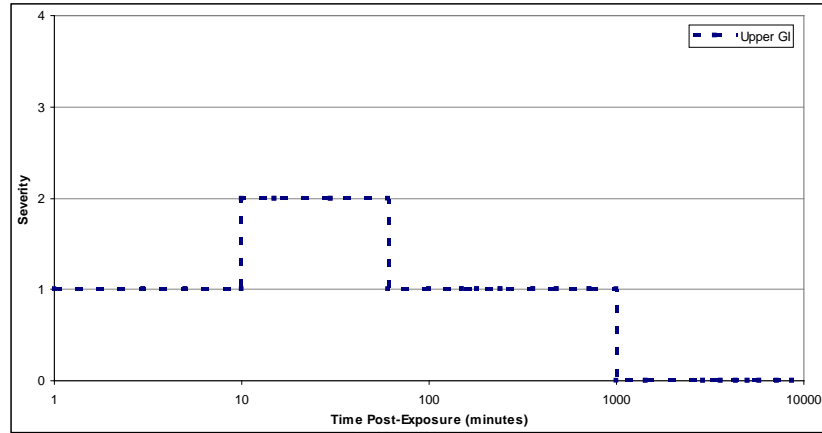
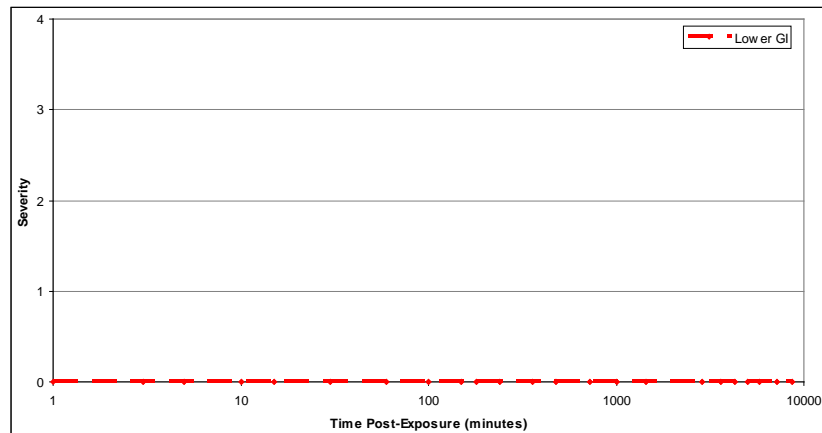


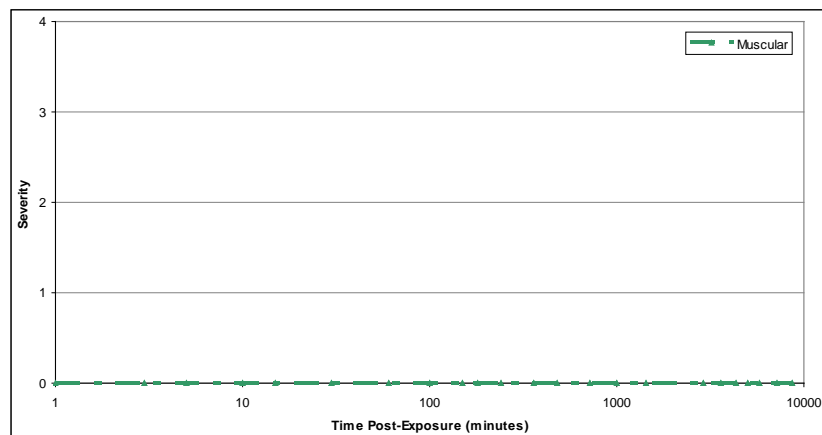
Figure 14. Injury Profile for Inhaled GB Vapor
Dosage Range 1 – < 6.5 mg-min/m³



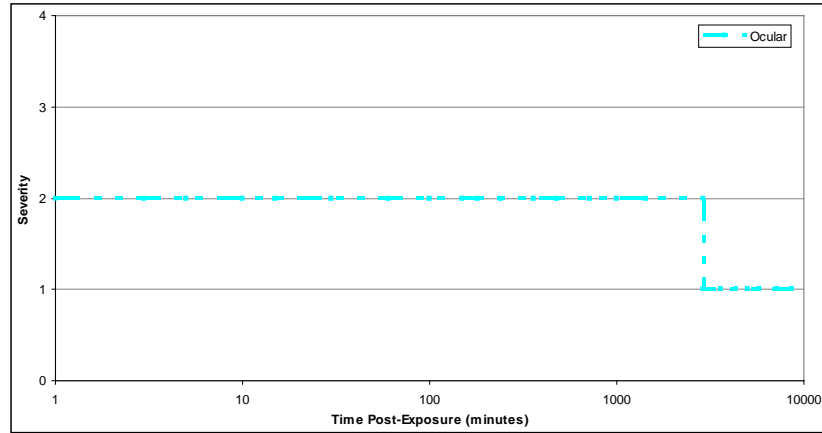
**Figure 15. Upper GI Symptom Progression for Inhaled GB Vapor
Dosage Range 6.5 – < 12 mg-min/m³**



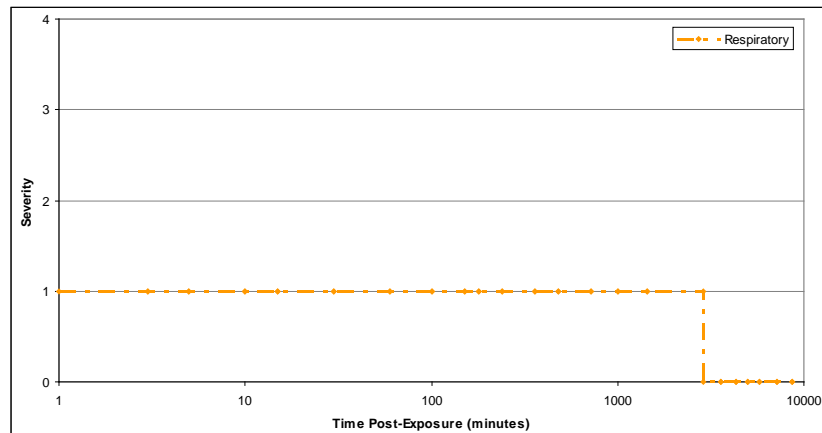
**Figure 16. Lower GI Symptom Progression for Inhaled GB Vapor
Dosage Range 6.5 – < 12 mg-min/m³**



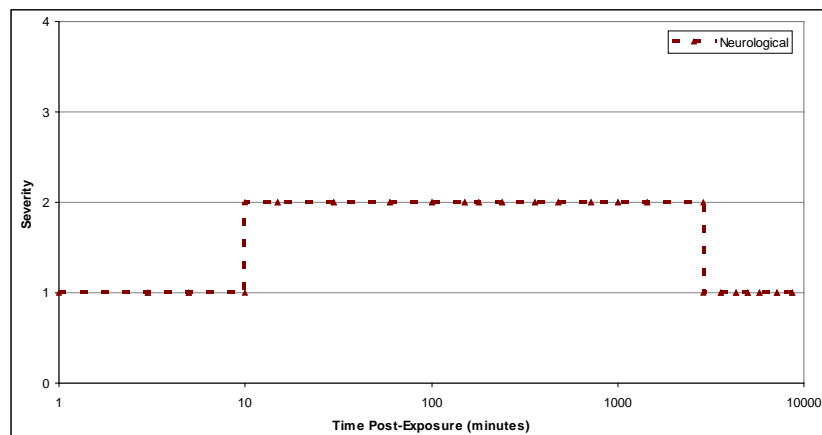
**Figure 17. Muscular Symptom Progression for Inhaled GB Vapor
Dosage Range 6.5 – < 12 mg-min/m³**



**Figure 18. Ocular Symptom Progression for Inhaled GB Vapor
Dosage Range 6.5 – < 12 mg-min/m³**



**Figure 19. Respiratory Symptom Progression for Inhaled GB Vapor
Dosage Range 6.5 – < 12 mg-min/m³**



**Figure 20. Neurological Symptom Progression for Inhaled GB Vapor
Dosage Range 6.5 – < 12 mg-min/m³**

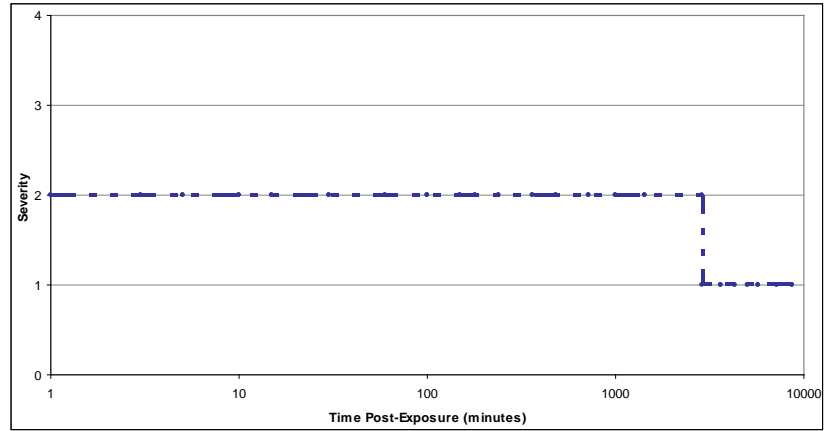
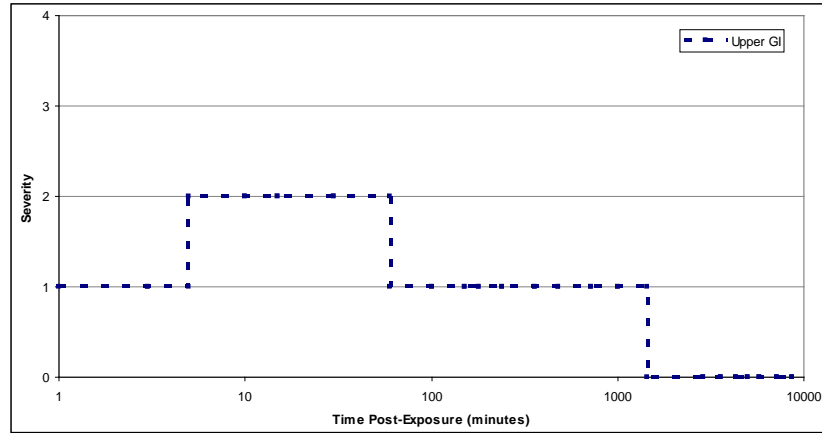
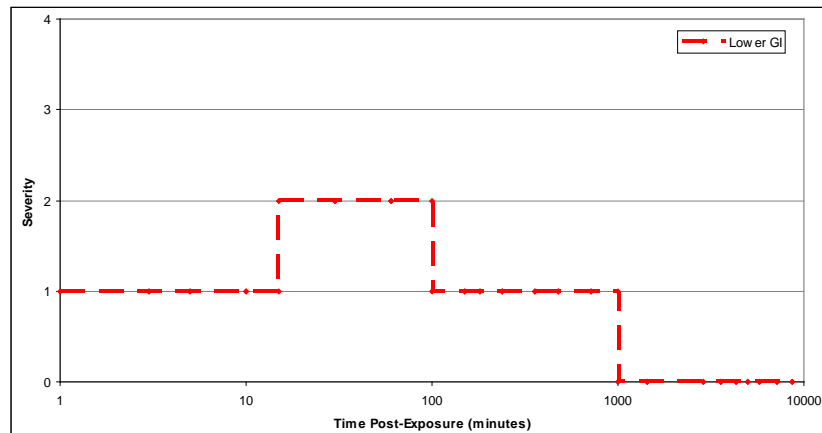


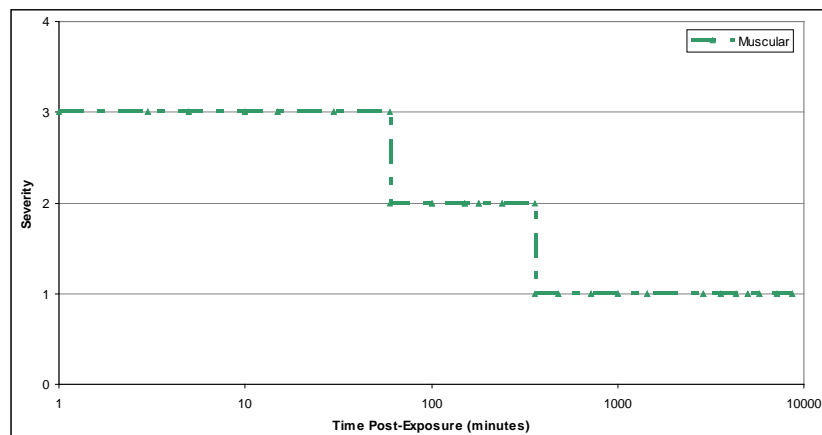
Figure 21. Injury Profile for Inhaled GB Vapor
Dosage Range 6.5 – < 12 mg-min/m³



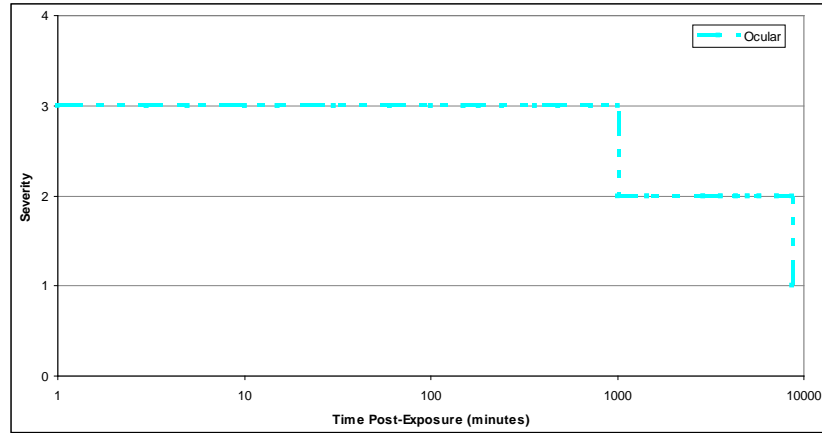
**Figure 22. Upper GI Symptom Progression for Inhaled GB Vapor
Dosage Range 12 – < 25 mg-min/m³**



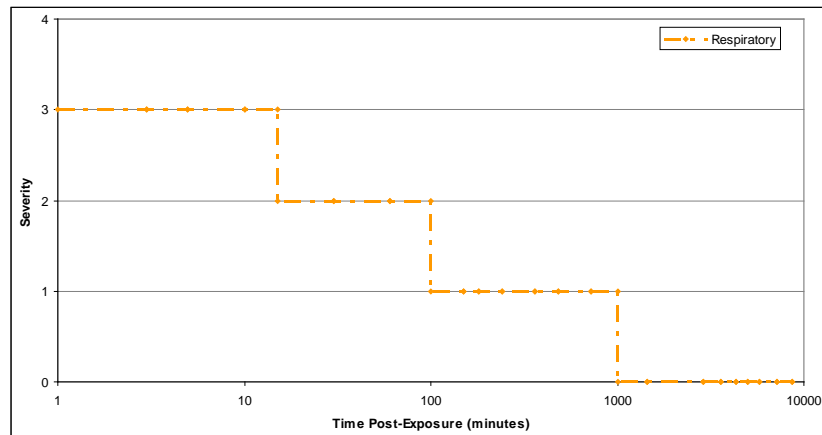
**Figure 23. Lower GI Symptom Progression for Inhaled GB Vapor
Dosage Range 12 – < 25 mg-min/m³**



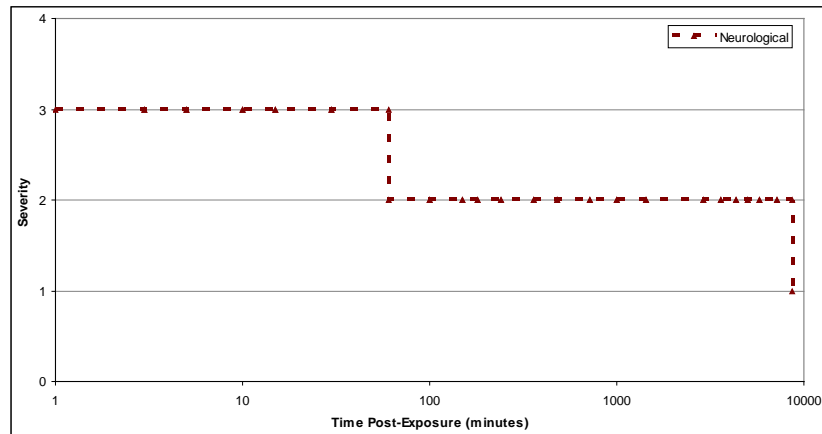
**Figure 24. Muscular Symptom Progression for Inhaled GB Vapor
Dosage Range 12 – < 25 mg-min/m³**



**Figure 25. Ocular Symptom Progression for Inhaled GB Vapor
Dosage Range 12 – < 25 mg-min/m³**



**Figure 26. Respiratory Symptom Progression for Inhaled GB Vapor
Dosage Range 12 – < 25 mg-min/m³**



**Figure 27. Neurological Symptom Progression for Inhaled GB Vapor
Dosage Range 12 – < 25 mg-min/m³**

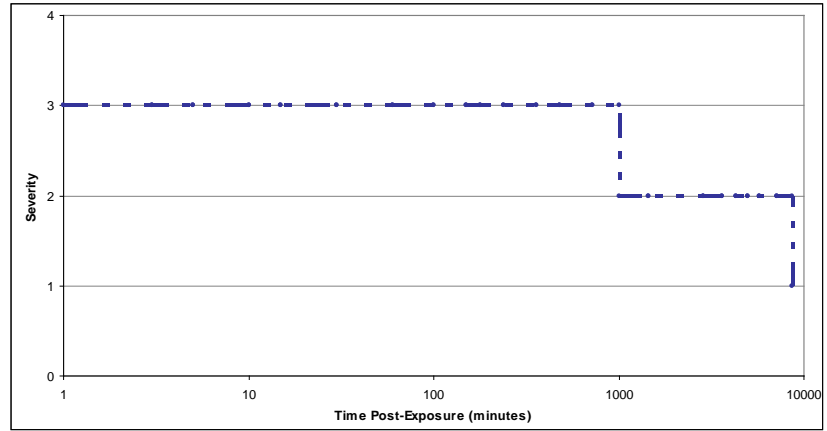
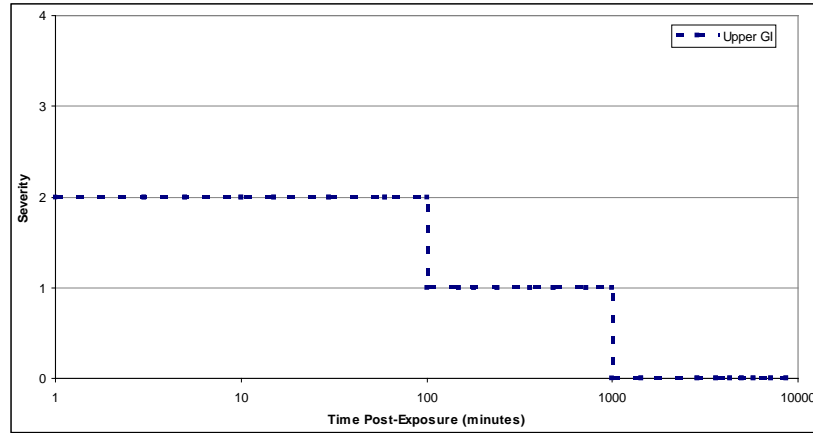
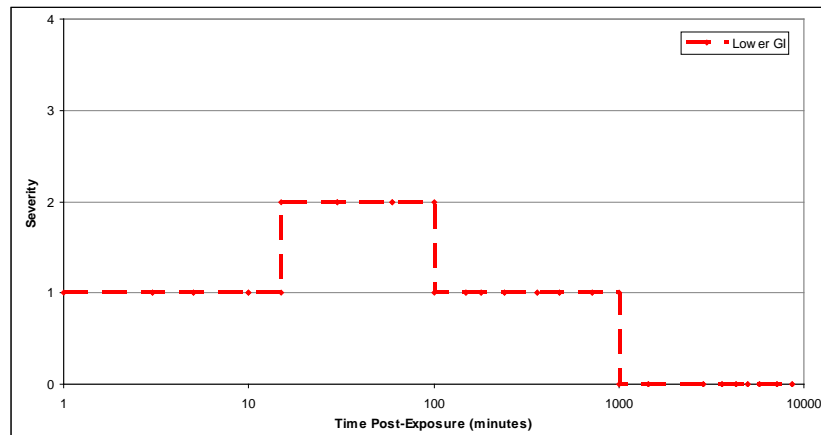


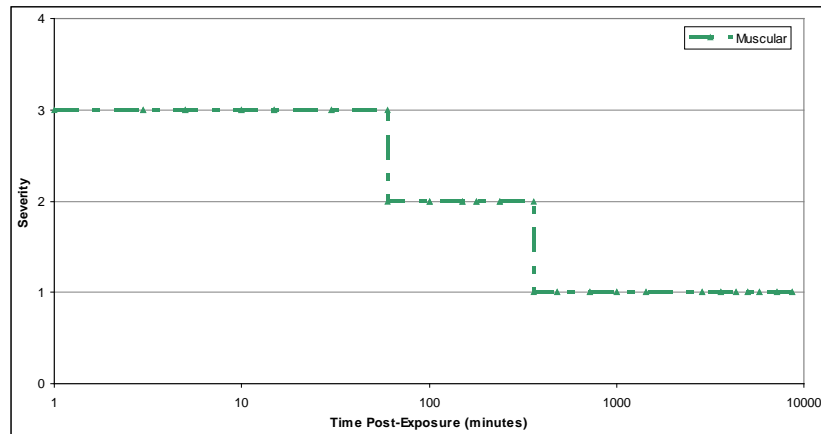
Figure 28. Injury Profile for Inhaled GB Vapor
Dosage Range 12 – < 25 mg-min/m³



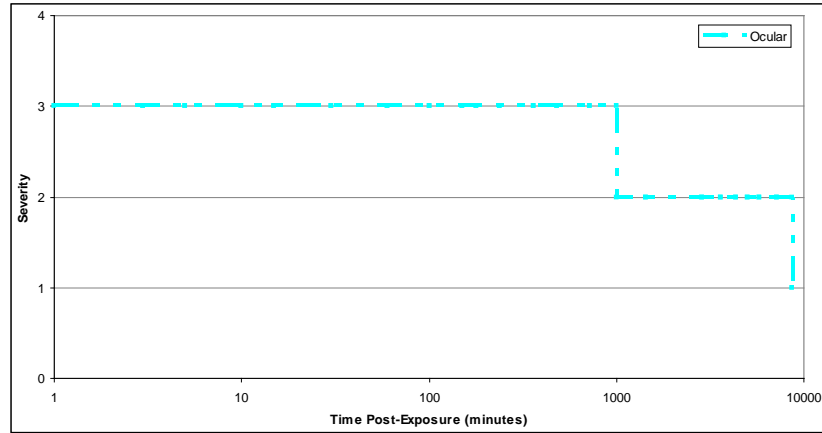
**Figure 29. Upper GI Symptom Progression for Inhaled GB Vapor
Dosage Range 25 – < 30 mg-min/m³**



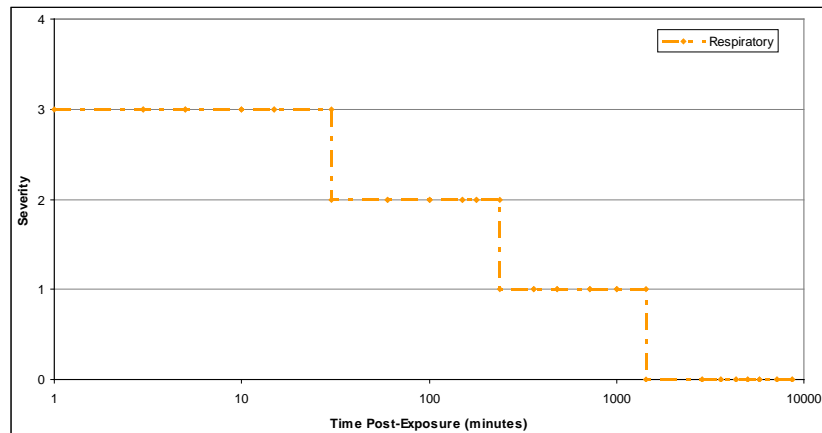
**Figure 30. Lower GI Symptom Progression for Inhaled GB Vapor
Dosage Range 25 – < 30 mg-min/m³**



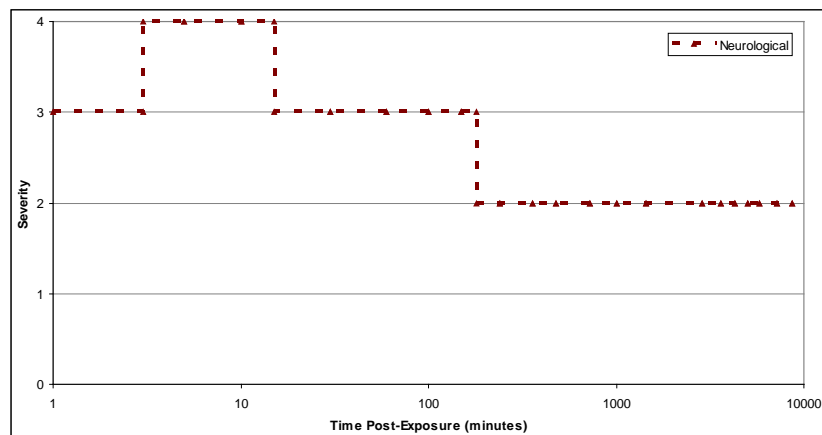
**Figure 31. Muscular Symptom Progression for Inhaled GB Vapor
Dosage Range 25 – < 30 mg-min/m³**



**Figure 32. Ocular Symptom Progression for Inhaled GB Vapor
Dosage Range 25 – < 30 mg-min/m³**



**Figure 33. Respiratory Symptom Progression for Inhaled GB Vapor
Dosage Range 25 – < 30 mg-min/m³**



**Figure 34. Neurological Symptom Progression for Inhaled GB Vapor
Dosage Range 25 – < 30 mg-min/m³**

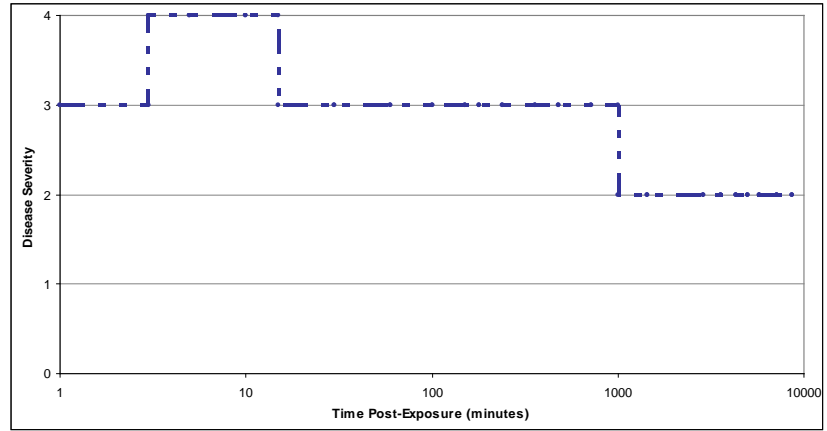
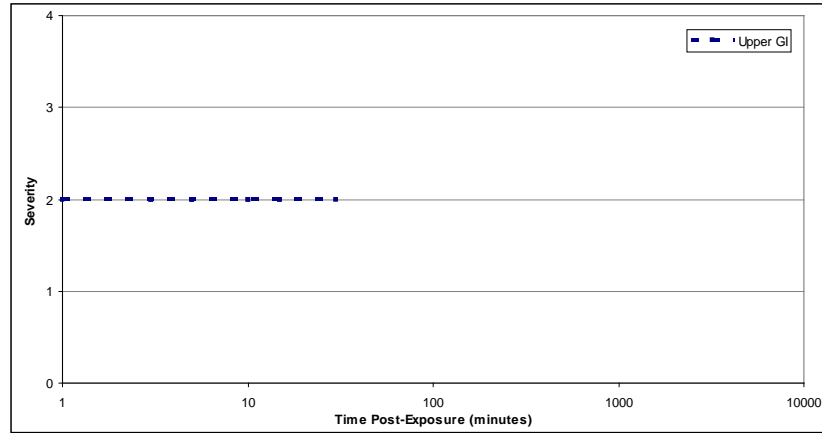
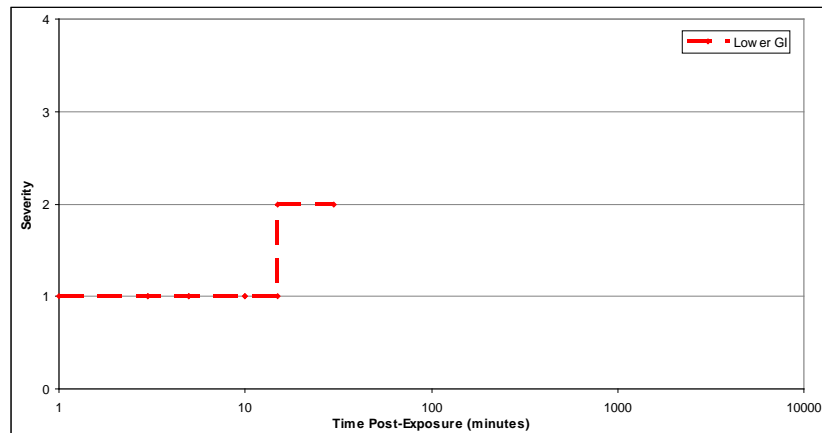


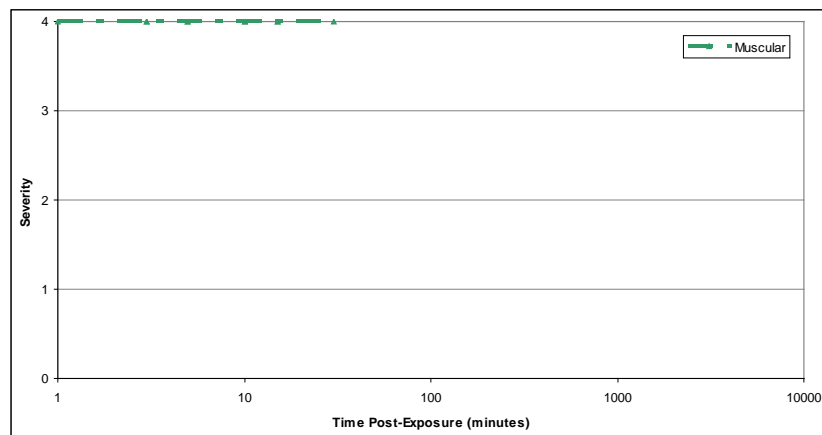
Figure 35. Injury Profile for Inhaled GB Vapor
Dosage Range 25 – < 30 mg-min/m³



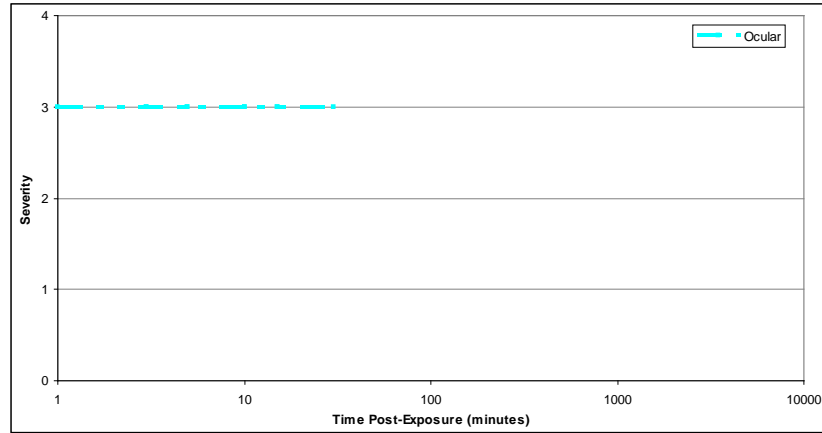
**Figure 36. Upper GI Symptom Progression for Inhaled GB Vapor
Dosage Range ≥ 30 mg-min/m³**



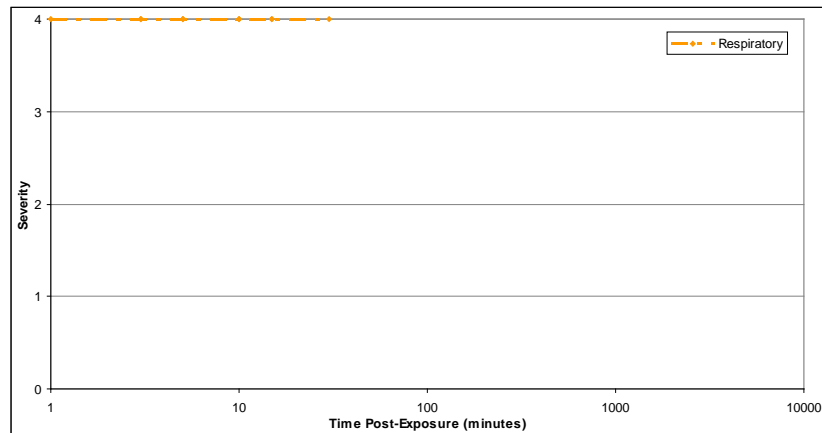
**Figure 37. Lower GI Symptom Progression for Inhaled GB Vapor
Dosage Range ≥ 30 mg-min/m³**



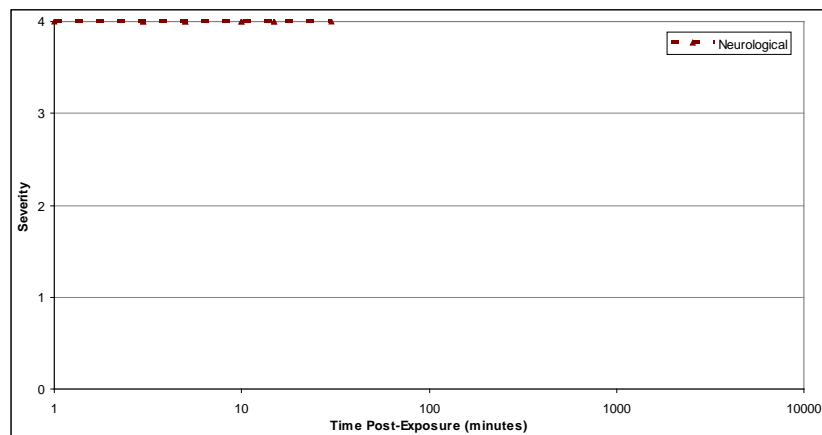
**Figure 38. Muscular Symptom Progression for Inhaled GB Vapor
Dosage Range ≥ 30 mg-min/m³**



**Figure 39. Ocular Symptom Progression for Inhaled GB Vapor
Dosage Range ≥ 30 mg-min/m³**



**Figure 40. Respiratory Symptom Progression for Inhaled GB Vapor
Dosage Range ≥ 30 mg-min/m³**



**Figure 41. Neurological Symptom Progression for Inhaled GB Vapor
Dosage Range ≥ 30 mg-min/m³**

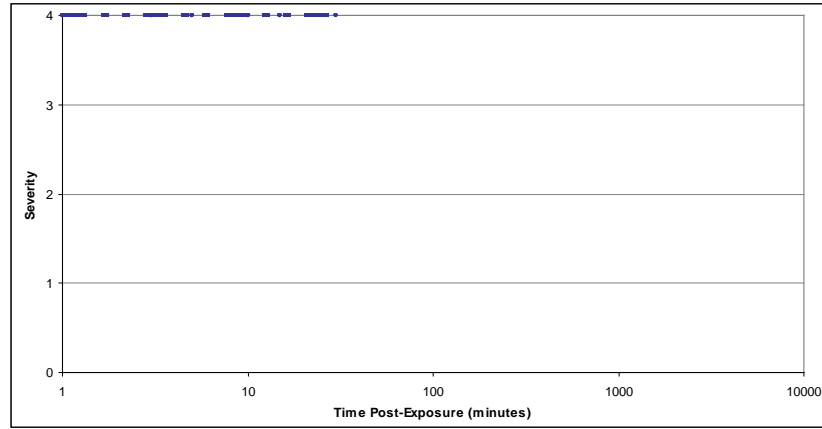


Figure 42. Injury Profile for Inhaled GB Vapor
Dosage Range ≥ 30 mg-min/m³

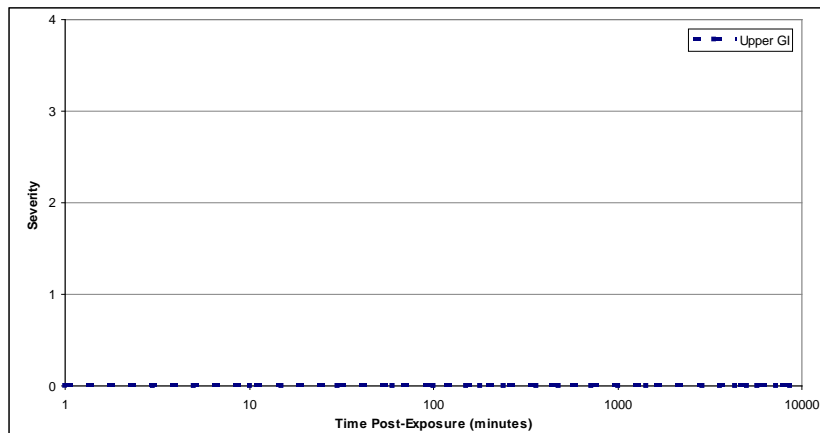


Figure 43. Upper GI Symptom Progression for Inhaled VX Vapor
Dosage Range 0.02 – < 0.3 mg-min/m³

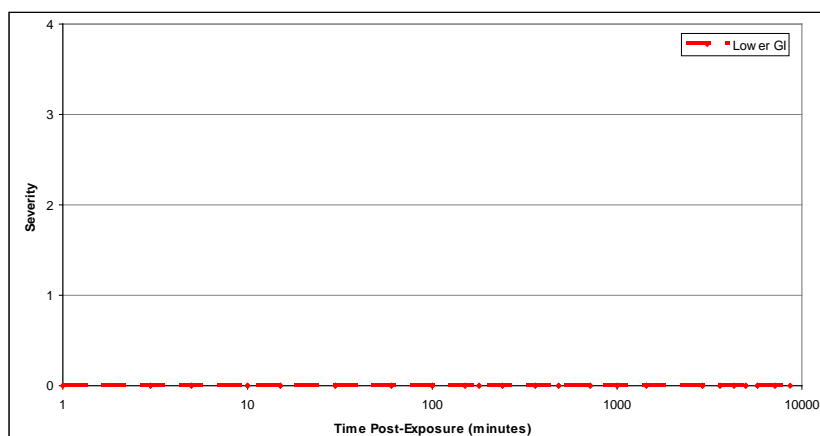


Figure 44. Lower GI Symptom Progression for Inhaled VX Vapor
Dosage Range 0.02 – < 0.3 mg-min/m³

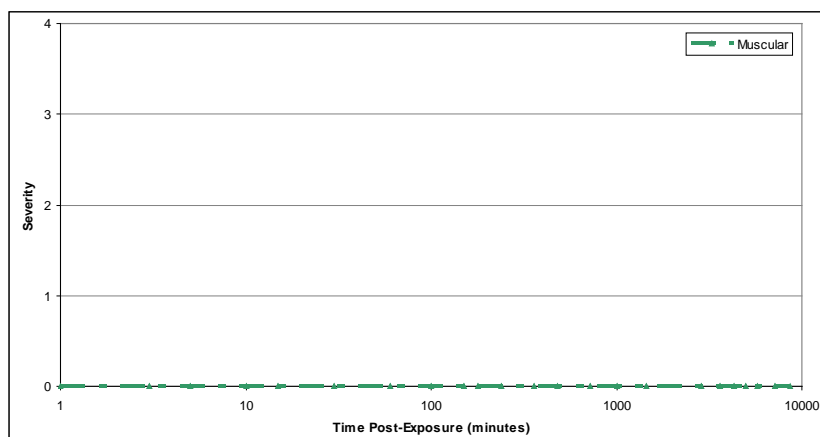
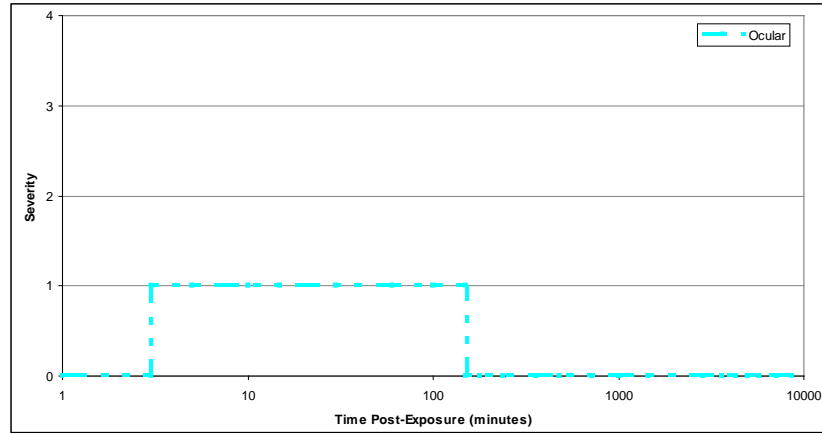
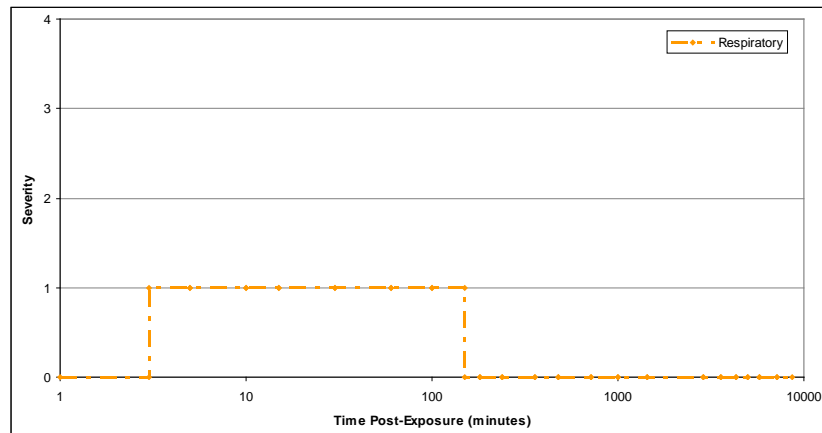


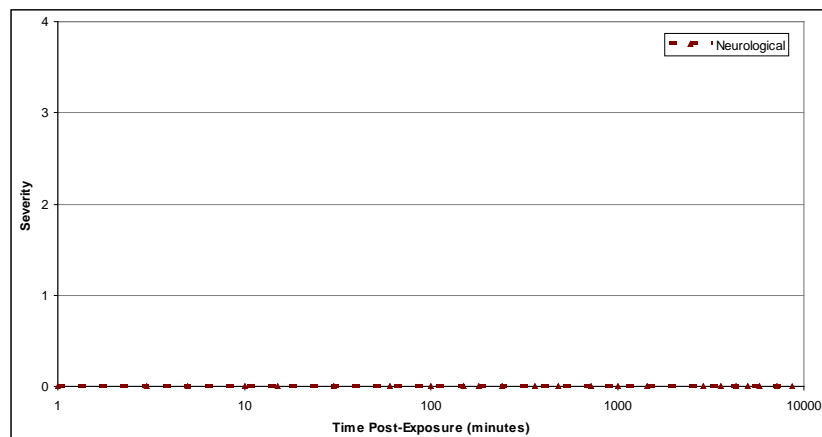
Figure 45. Muscular Symptom Progression for Inhaled VX Vapor
Dosage Range 0.02 – < 0.3 mg-min/m³



**Figure 46. Ocular Symptom Progression for Inhaled VX Vapor
Dosage Range 0.02 – < 0.3 mg-min/m³**



**Figure 47. Respiratory Symptom Progression for Inhaled VX Vapor
Dosage Range 0.02 – < 0.3 mg-min/m³**



**Figure 48. Neurological Symptom Progression for Inhaled VX Vapor
Dosage Range 0.02 – < 0.3 mg-min/m³**

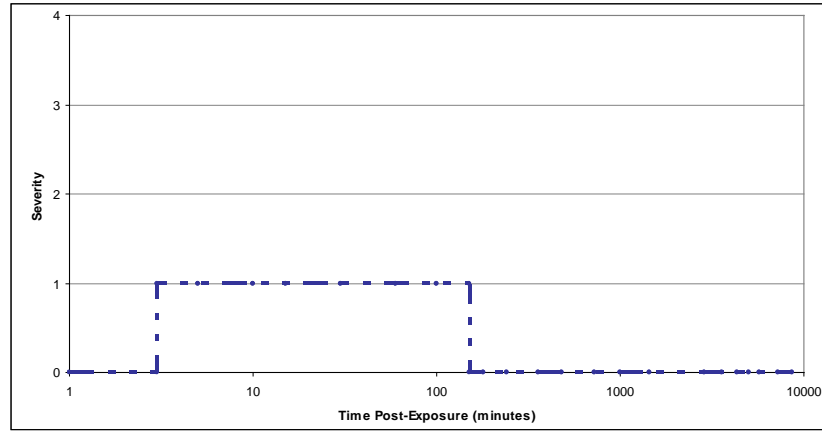
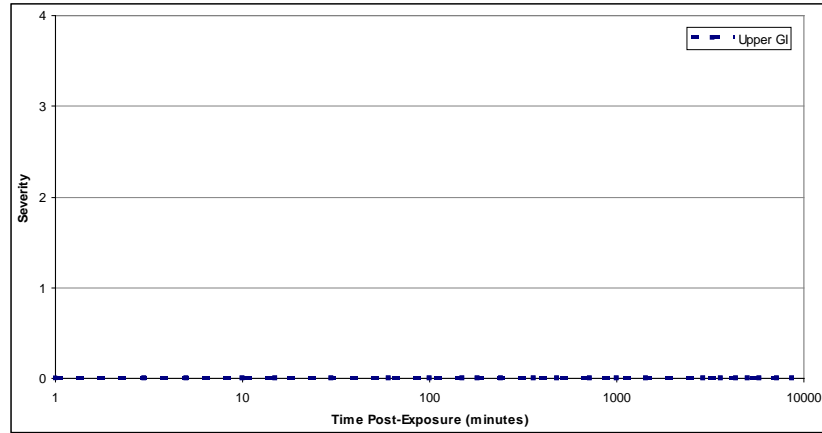
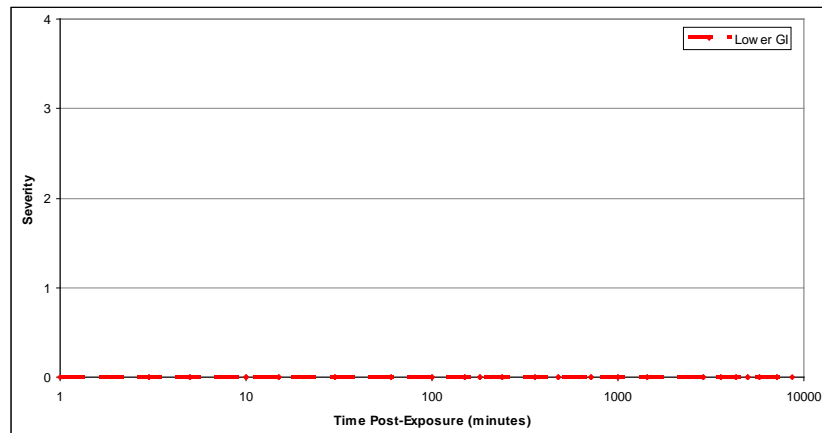


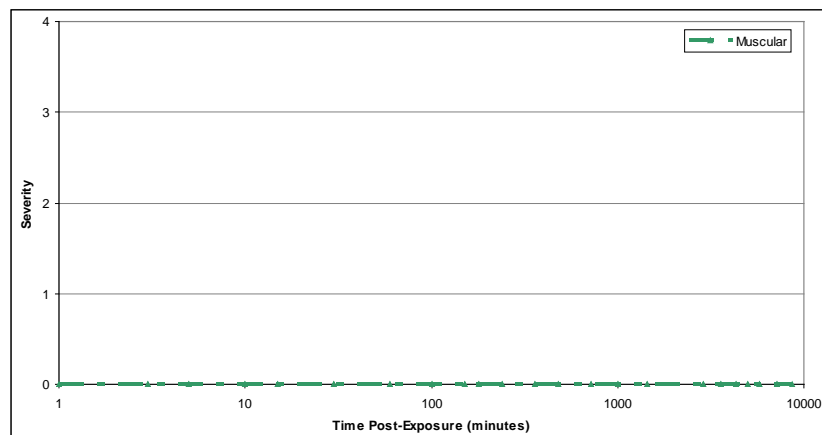
Figure 49. Injury Profile for Inhaled VX Vapor
Dosage Range 0.02 – < 0.3 mg-min/m³



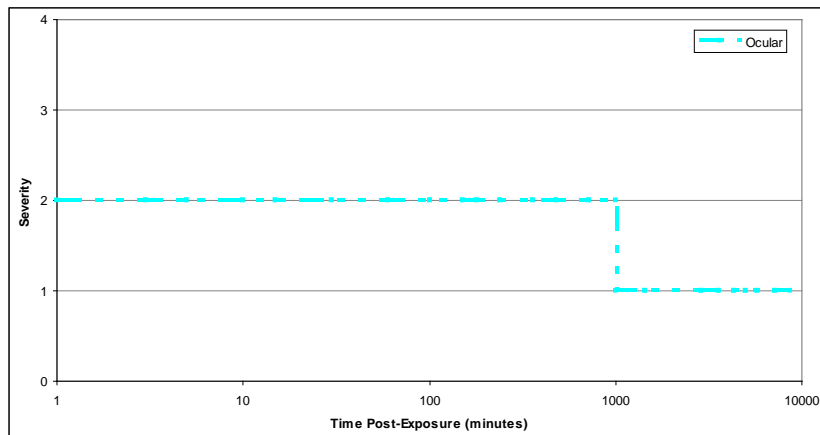
**Figure 50. Upper GI Symptom Progression for Inhaled VX Vapor
Dosage Range 0.3 – < 2 mg-min/m³**



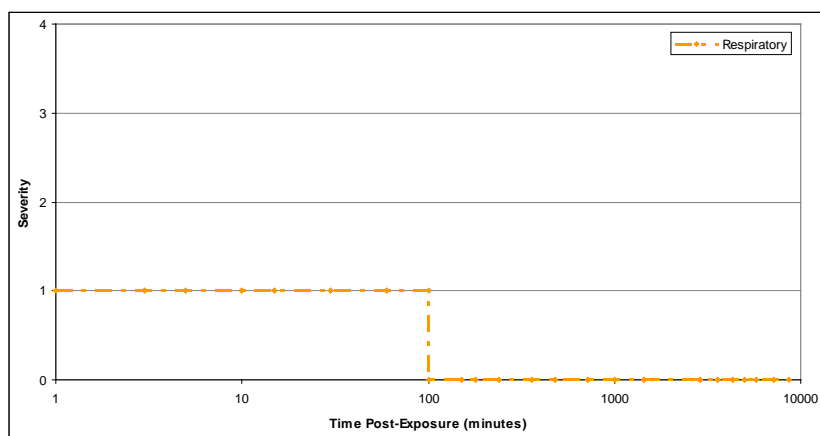
**Figure 51. Lower GI Symptom Progression for Inhaled VX Vapor
Dosage Range 0.3 – < 2 mg-min/m³**



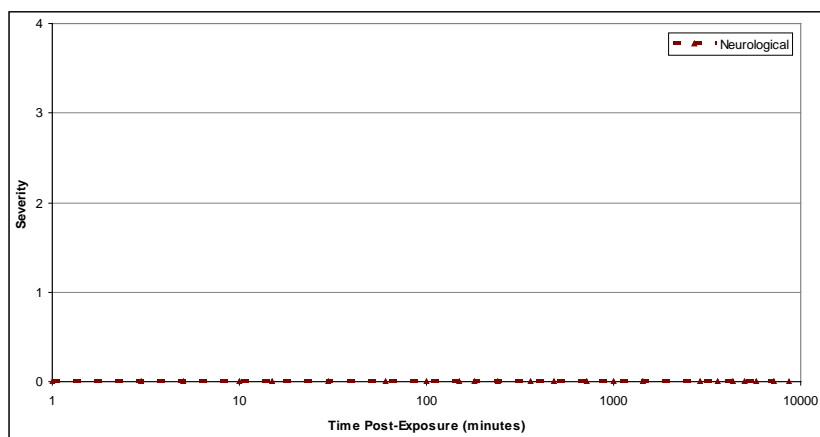
**Figure 52. Muscular Symptom Progression for Inhaled VX Vapor
Dosage Range 0.3 – < 2 mg-min/m³**



**Figure 53. Ocular Symptom Progression for Inhaled VX Vapor
Dosage Range 0.3 – < 2 mg-min/m³**



**Figure 54. Respiratory Symptom Progression for Inhaled VX Vapor
Dosage Range 0.3 – < 2 mg-min/m³**



**Figure 55. Neurological Symptom Progression for Inhaled VX Vapor
Dosage Range 0.3 – < 2 mg-min/m³**

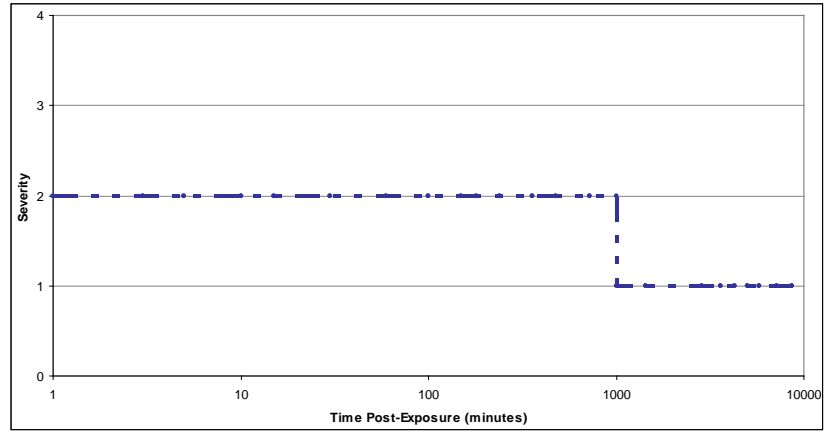
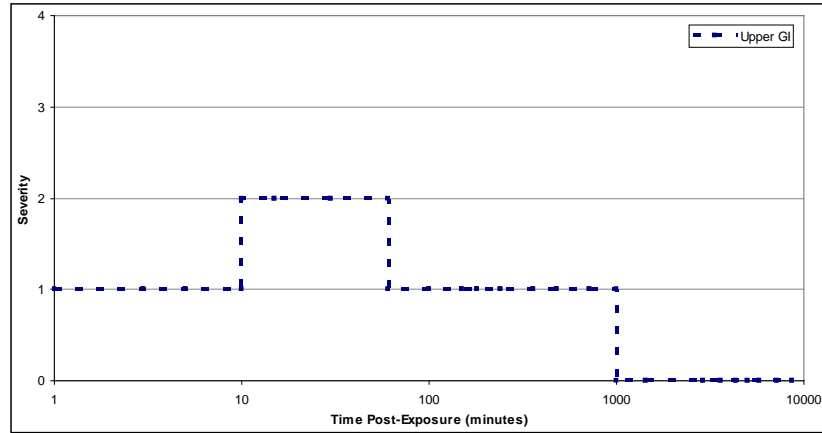
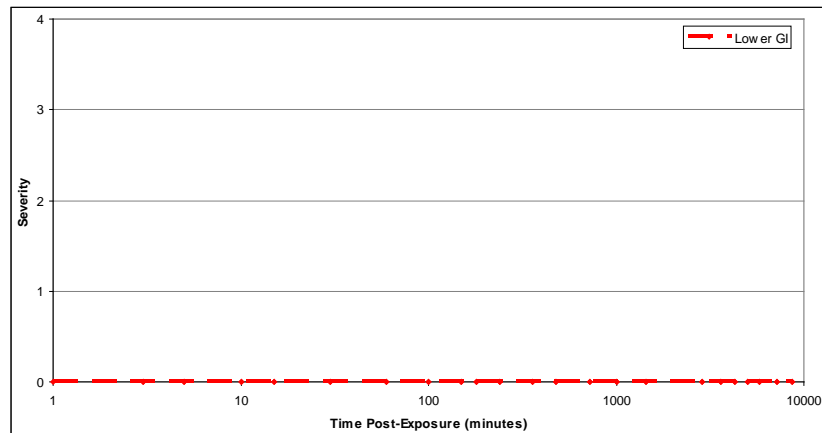


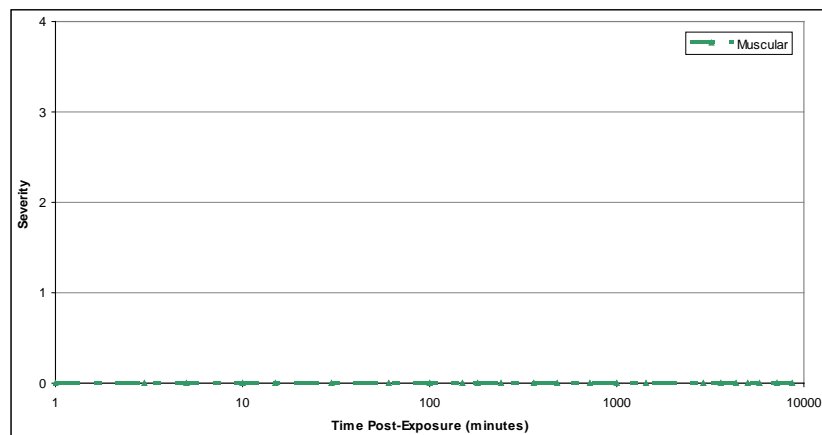
Figure 56. Injury Profile for Inhaled VX Vapor
Dosage Range 0.3 – < 2 mg-min/m³



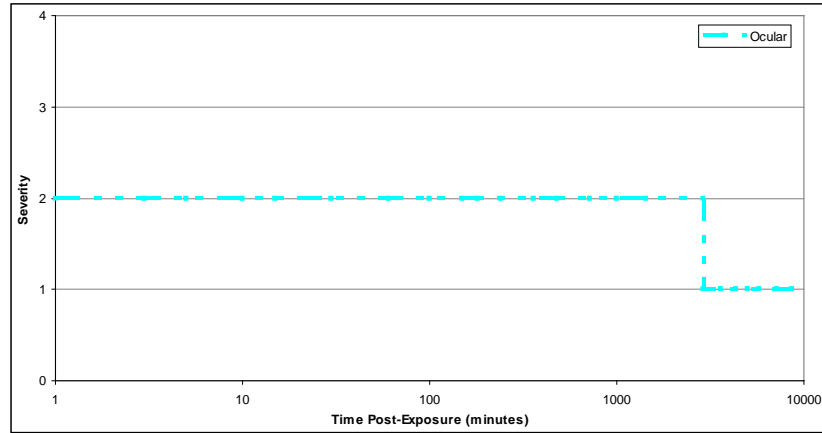
**Figure 57. Upper GI Symptom Progression for Inhaled VX Vapor
Dosage Range 2 – $< 4 \text{ mg-min/m}^3$**



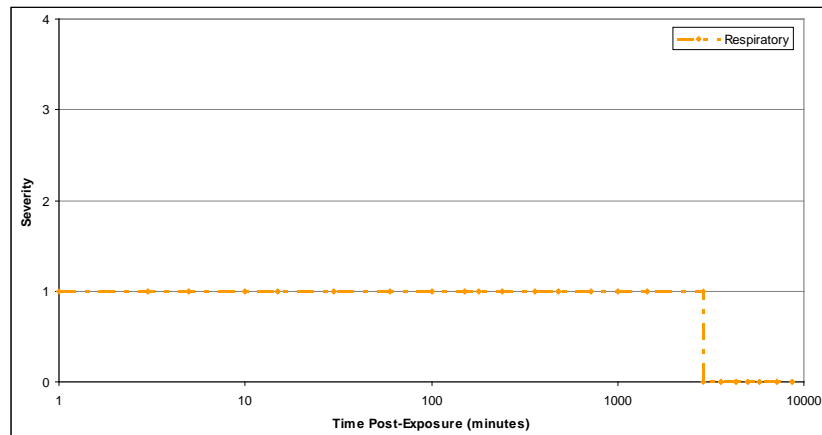
**Figure 58. Lower GI Symptom Progression for Inhaled VX Vapor
Dosage Range 2 – $< 4 \text{ mg-min/m}^3$**



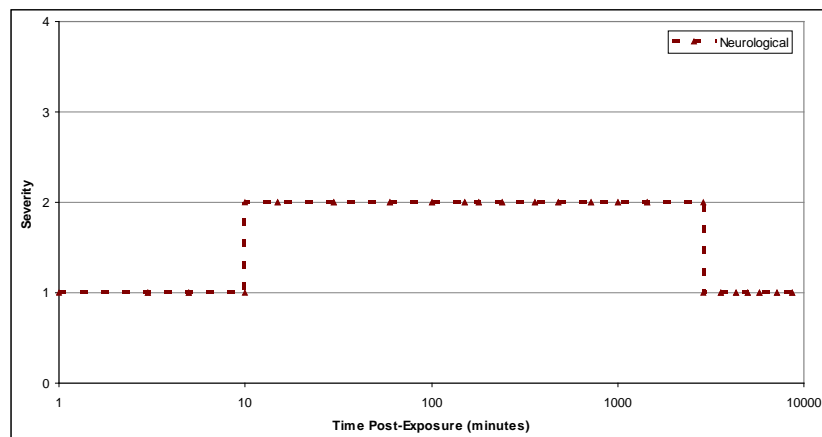
**Figure 59. Muscular Symptom Progression for Inhaled VX Vapor
Dosage Range 2 – $< 4 \text{ mg-min/m}^3$**



**Figure 60. Ocular Symptom Progression for Inhaled VX Vapor
Dosage Range 2 – $< 4 \text{ mg-min/m}^3$**



**Figure 61. Respiratory Symptom Progression for Inhaled VX Vapor
Dosage Range 2 – $< 4 \text{ mg-min/m}^3$**



**Figure 62. Neurological Symptom Progression for Inhaled VX Vapor
Dosage Range 2 – $< 4 \text{ mg-min/m}^3$**

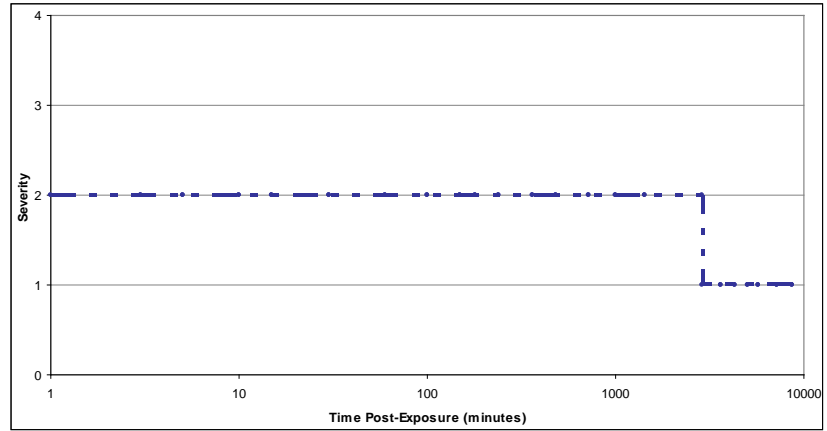
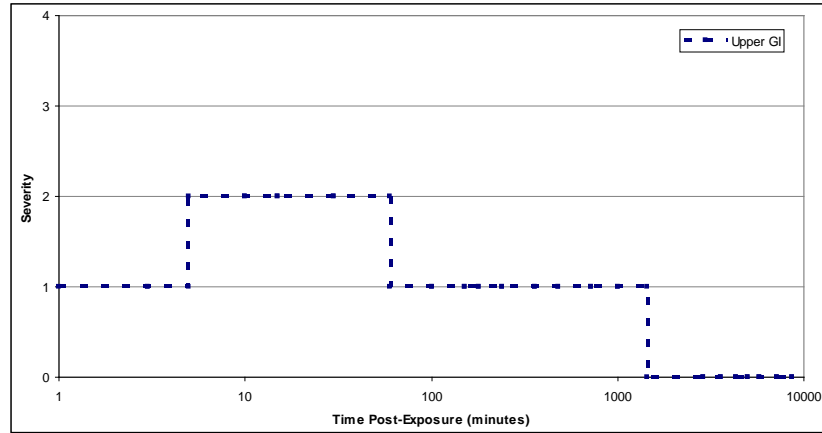
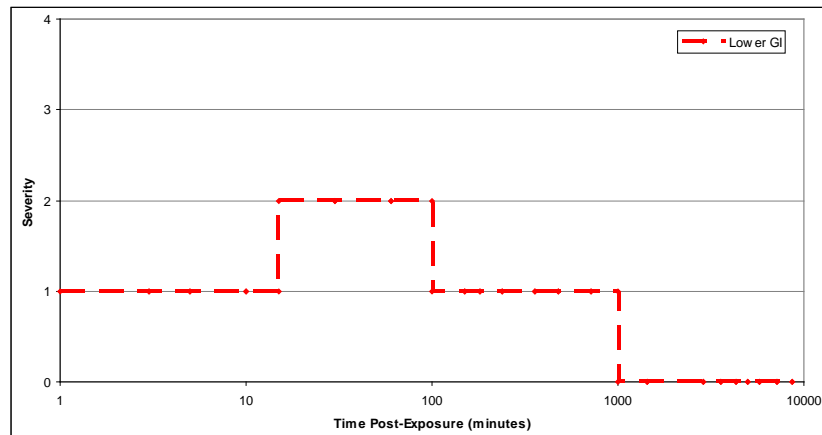


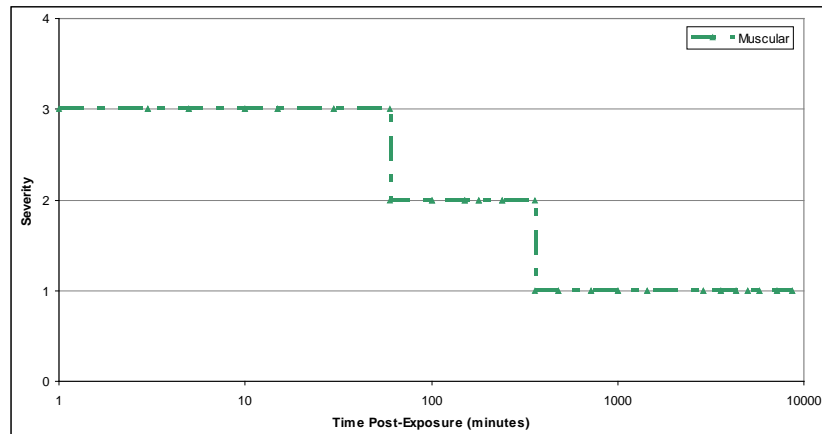
Figure 63. Injury Profile for Inhaled VX
Vapor Dosage Range 2 – < 4 mg-min/m³



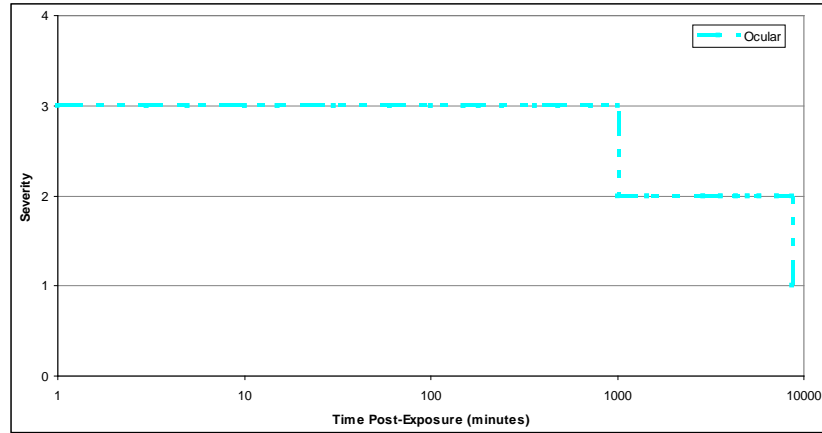
**Figure 64. Upper GI Symptom Progression for Inhaled VX Vapor
Dosage Range 4 – $< 10 \text{ mg-min/m}^3$**



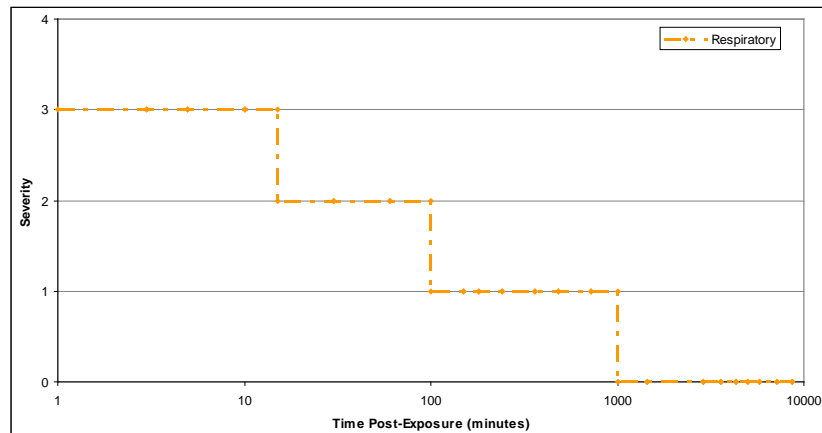
**Figure 65. Lower GI Symptom Progression for Inhaled VX Vapor
Dosage Range 4 – $< 10 \text{ mg-min/m}^3$**



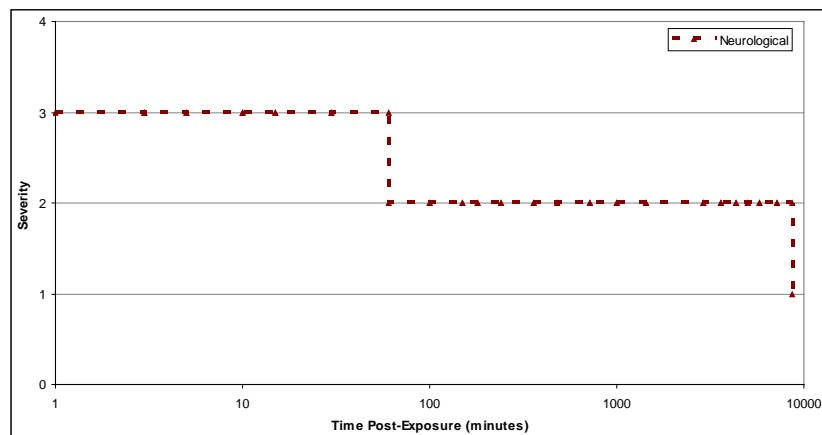
**Figure 66. Muscular Symptom Progression for Inhaled VX Vapor
Dosage Range 4 – $< 10 \text{ mg-min/m}^3$**



**Figure 67. Ocular Symptom Progression for Inhaled VX Vapor
Dosage Range 4 – $< 10 \text{ mg-min/m}^3$**



**Figure 68. Respiratory Symptom Progression for Inhaled VX Vapor
Dosage Range 4 – $< 10 \text{ mg-min/m}^3$**



**Figure 69. Neurological Symptom Progression for Inhaled VX Vapor
Dosage Range 4 – $< 10 \text{ mg-min/m}^3$**

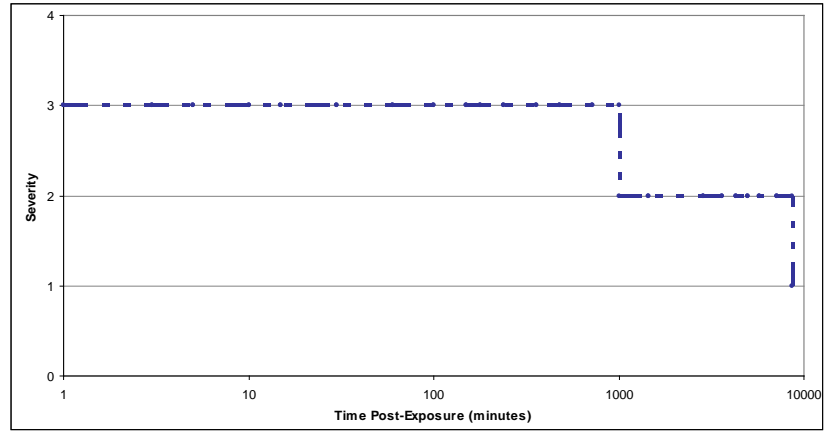
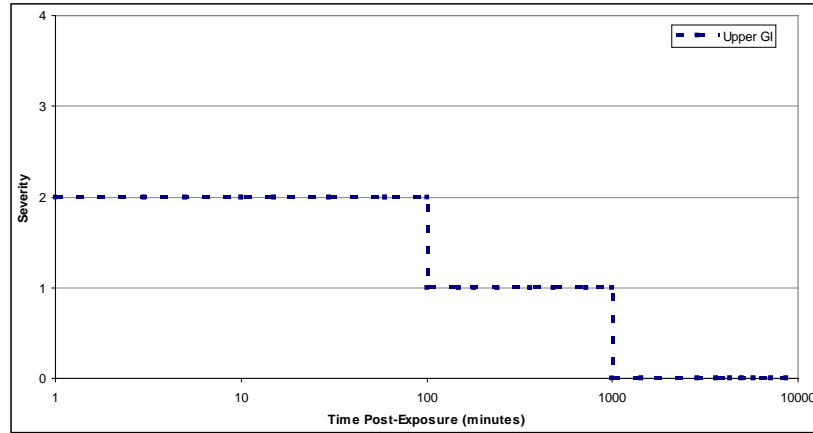
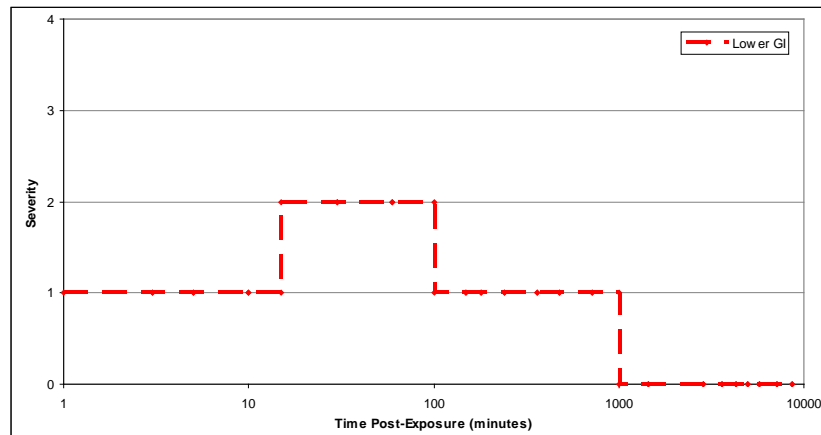


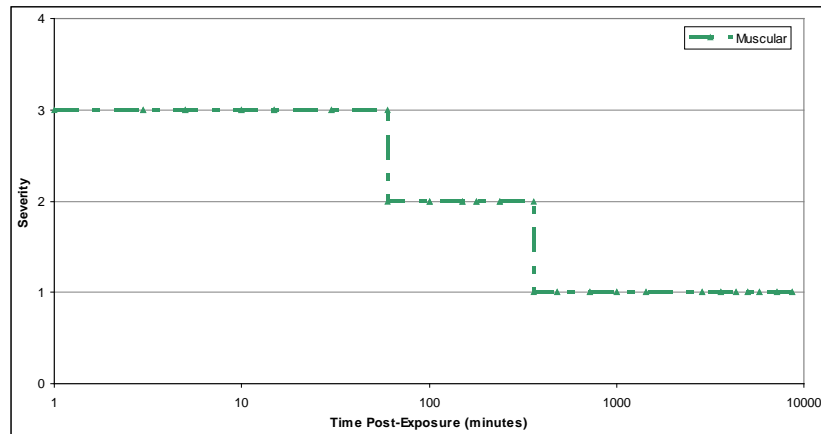
Figure 70. Injury Profile for Inhaled VX Vapor
Dosage Range 4 – $< 10 \text{ mg-min/m}^3$



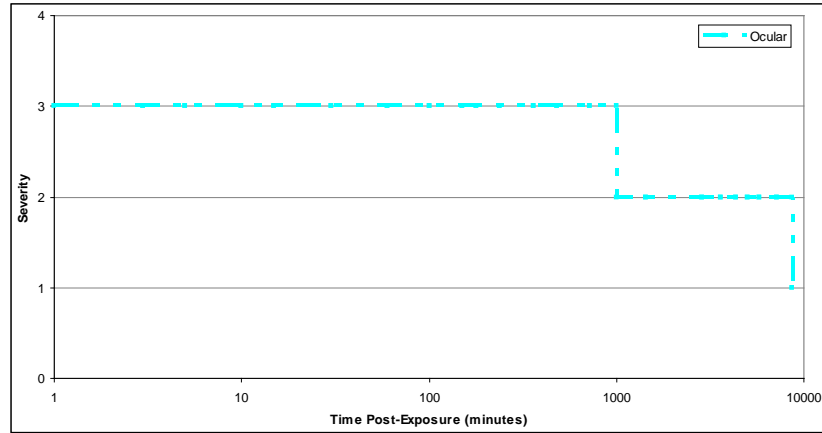
**Figure 71. Upper GI Symptom Progression for Inhaled VX Vapor
Dosage Range 10 – < 13 mg-min/m³**



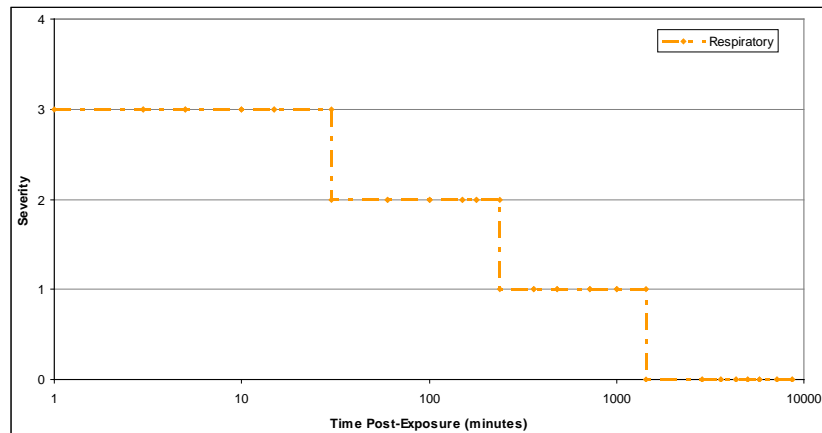
**Figure 72. Lower GI Symptom Progression for Inhaled VX Vapor
Dosage Range 10 – < 13 mg-min/m³**



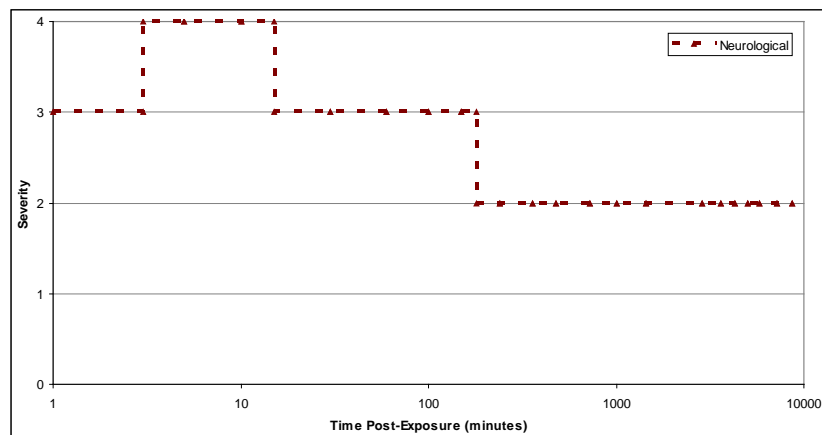
**Figure 73. Muscular Symptom Progression for Inhaled VX Vapor
Dosage Range 10 – < 13 mg-min/m³**



**Figure 74. Ocular Symptom Progression for Inhaled VX Vapor
Dosage Range 10 – < 13 mg-min/m³**



**Figure 75. Respiratory Symptom Progression for Inhaled VX Vapor
Dosage Range 10 – < 13 mg-min/m³**



**Figure 76. Neurological Symptom Progression for Inhaled VX Vapor
Dosage Range 10 – < 13 mg-min/m³**

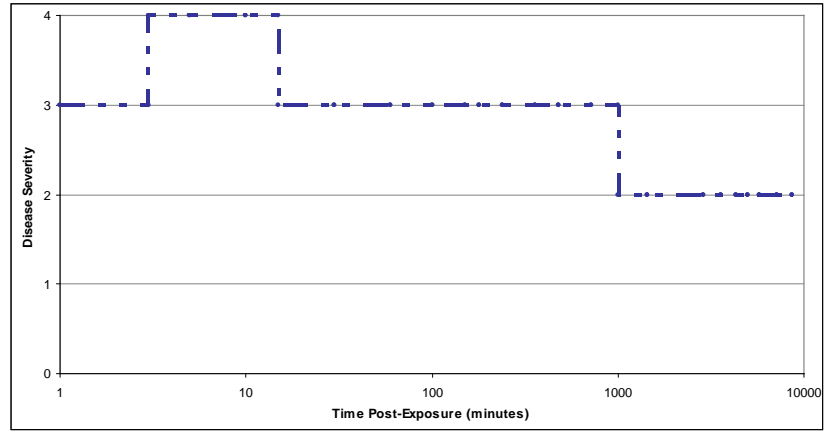
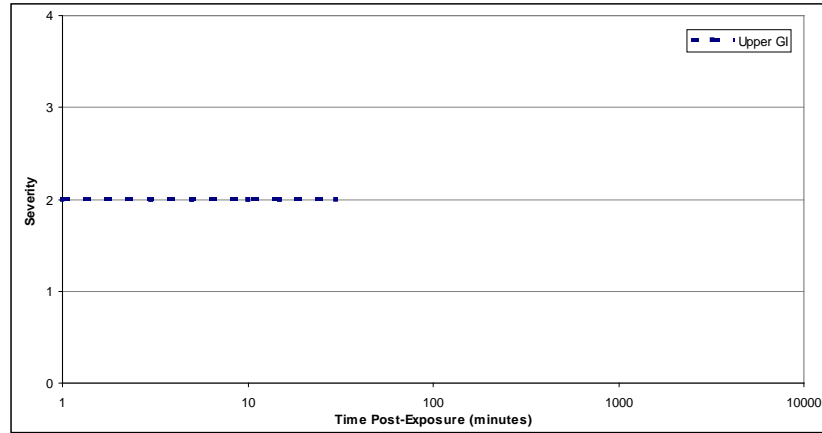
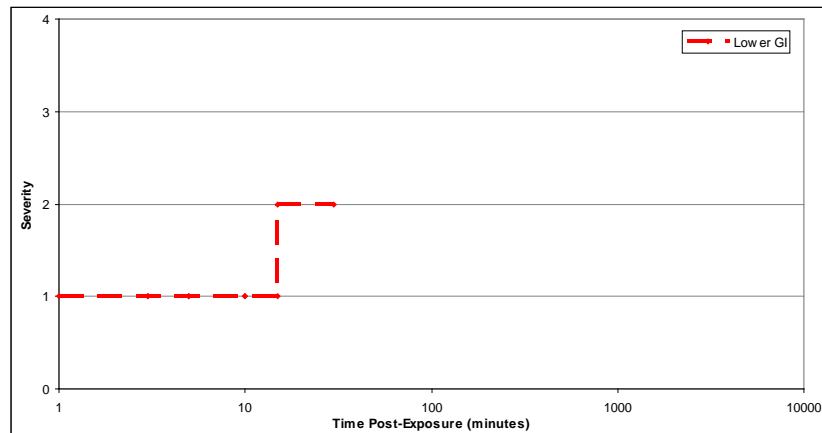


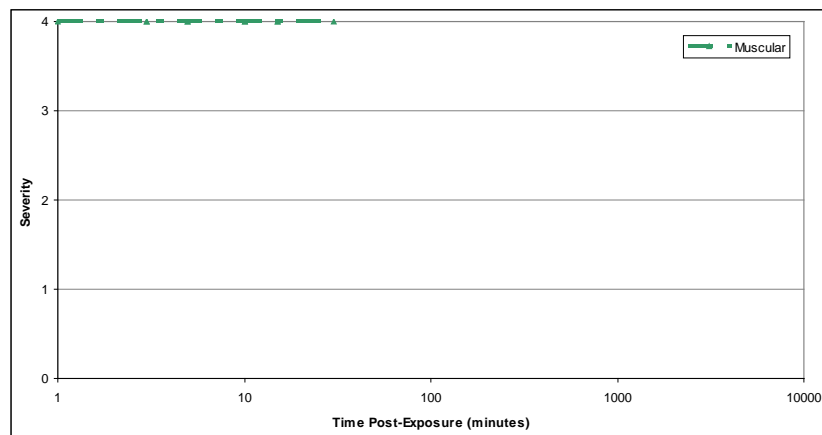
Figure 77. Injury Profile for Inhaled VX Vapor
Dosage Range 10 – < 13 mg-min/m³



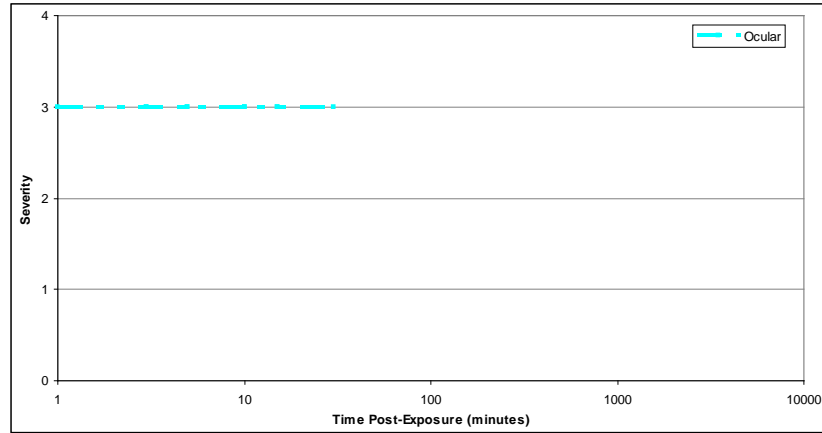
**Figure 78. Upper GI Symptom Progression for Inhaled VX Vapor
Dosage Range ≥ 13 mg-min/m³**



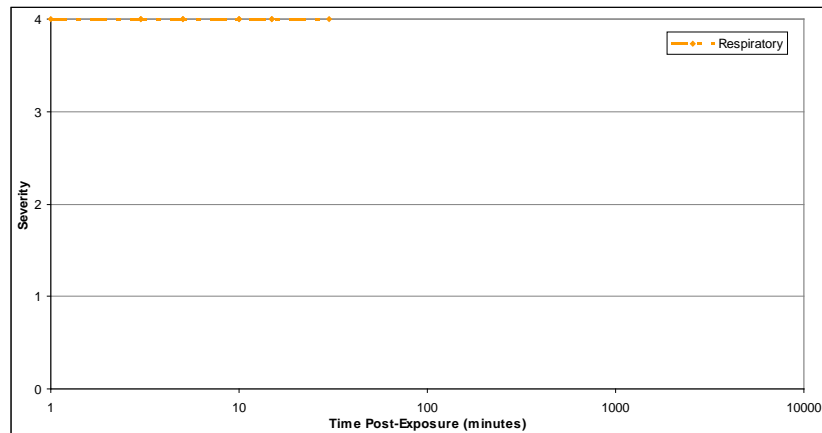
**Figure 79. Lower GI Symptom Progression for Inhaled VX Vapor
Dosage Range ≥ 13 mg-min/m³**



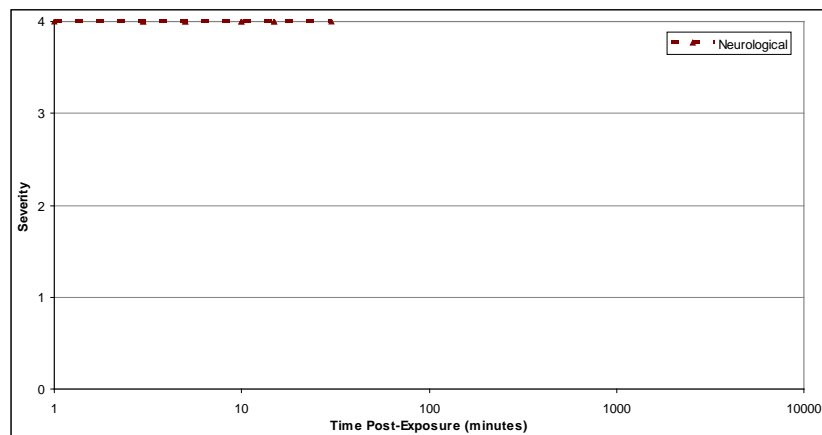
**Figure 80. Muscular Symptom Progression for Inhaled VX Vapor
Dosage Range ≥ 13 mg-min/m³**



**Figure 81. Ocular Symptom Progression for Inhaled VX Vapor
Dosage Range $\geq 13 \text{ mg-min/m}^3$**



**Figure 82. Respiratory Symptom Progression for Inhaled VX Vapor
Dosage Range $\geq 13 \text{ mg-min/m}^3$**



**Figure 83. Neurological Symptom Progression for Inhaled VX Vapor
Dosage Range $\geq 13 \text{ mg-min/m}^3$**

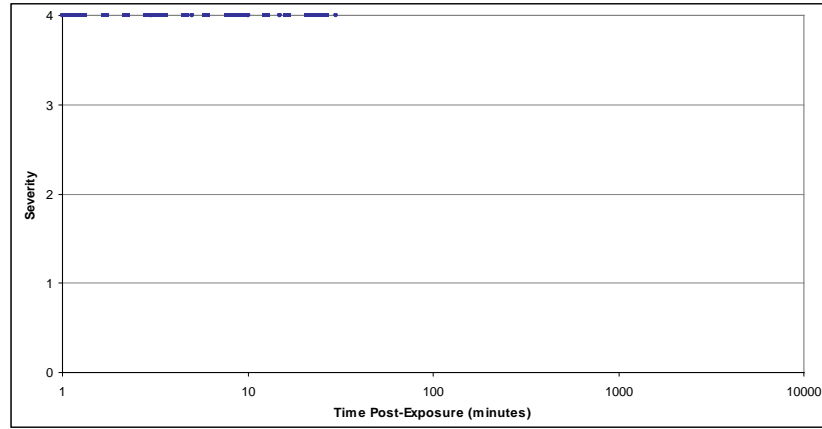
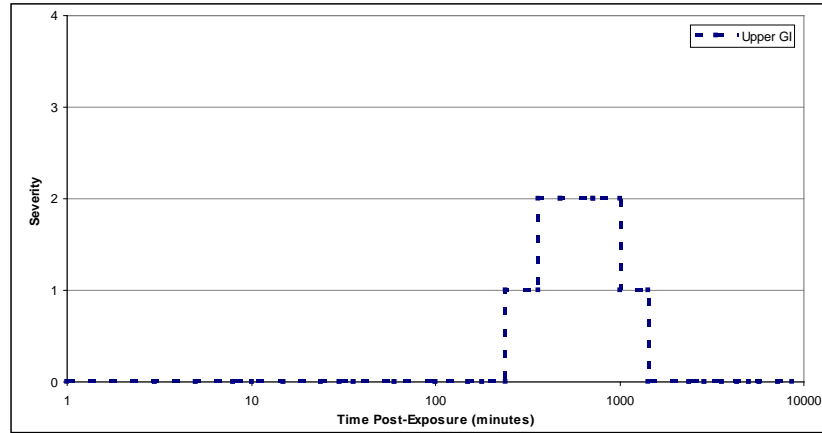
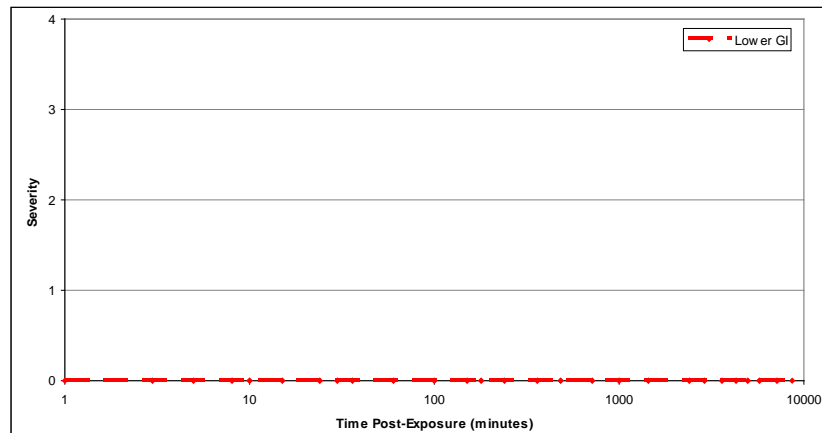


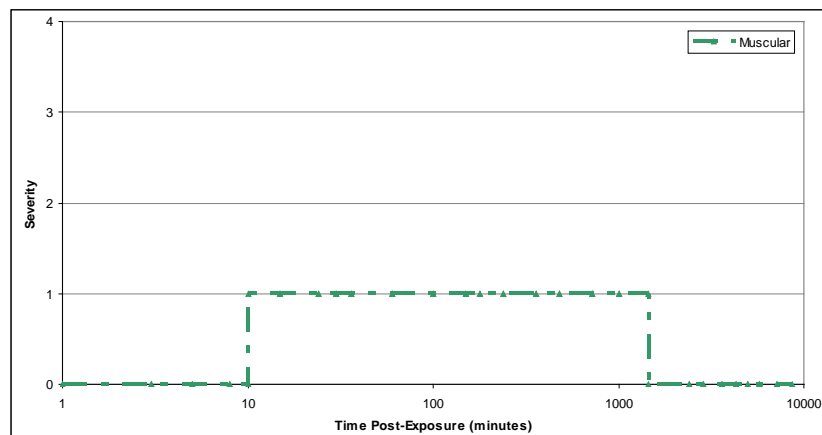
Figure 84. Injury Profile for Inhaled VX Vapor
Dosage Range ≥ 13 mg-min/m³



**Figure 85. Upper GI Symptom Progression for Percutaneous VX Liquid
Dose Range 0.8 – < 1.6 mg/man***



**Figure 86. Lower GI Symptom Progression for Percutaneous VX Liquid
Dose Range 0.8 – < 1.6 mg/man***



**Figure 87. Muscular Symptom Progression for Percutaneous VX Liquid
Dose Range 0.8 – < 1.6 mg/man***

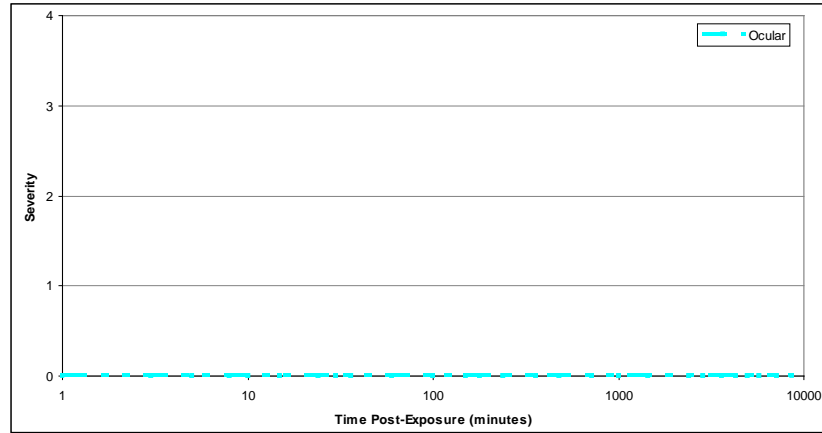


Figure 88. Ocular Symptom Progression for Percutaneous VX Liquid
Dose Range 0.8 – < 1.6 mg/man*

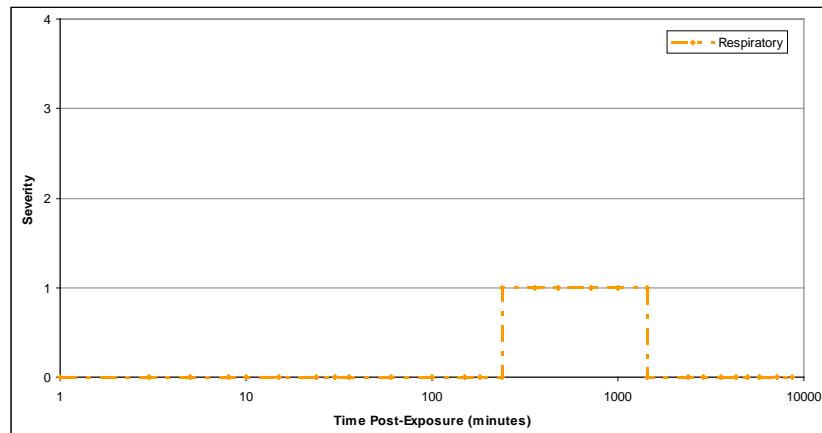


Figure 89. Respiratory Symptom Progression for Percutaneous VX Liquid
Dose Range 0.8 – < 1.6 mg/man*

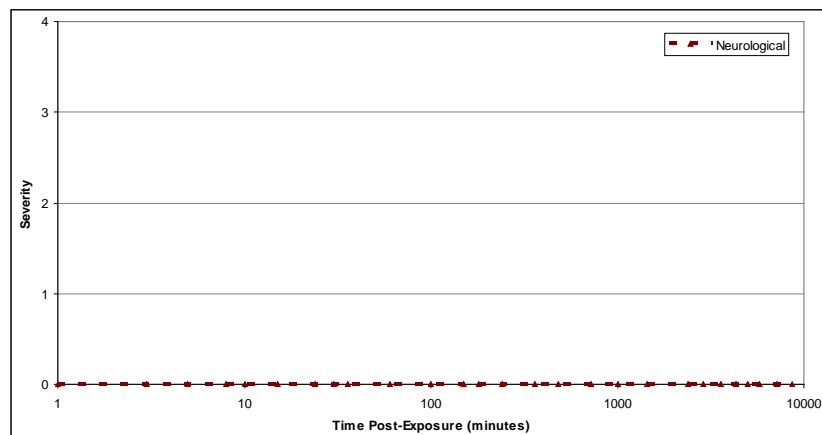


Figure 90. Neurological Symptom Progression for Percutaneous VX Liquid
Dose Range 0.8 – < 1.6 mg/man*

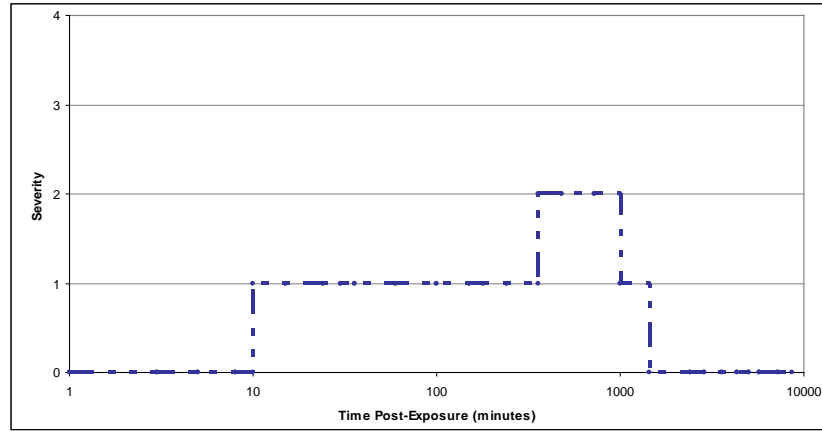


Figure 91. Injury Profile for Percutaneous VX Liquid
Dose Range 0.8 – < 1.6 mg/man*

* Symptom progressions and injury profiles for percutaneous VX were added post NATO SME meeting; progressions and profiles were derived based on literature and recommendations from US SMEs.

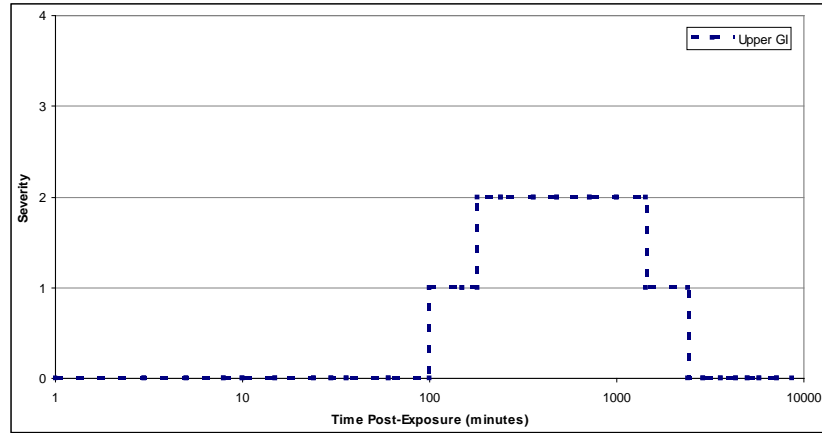


Figure 92. Upper GI Symptom Progression for Percutaneous VX Liquid
Dose Range 1.6 – < 3.9 mg/man*

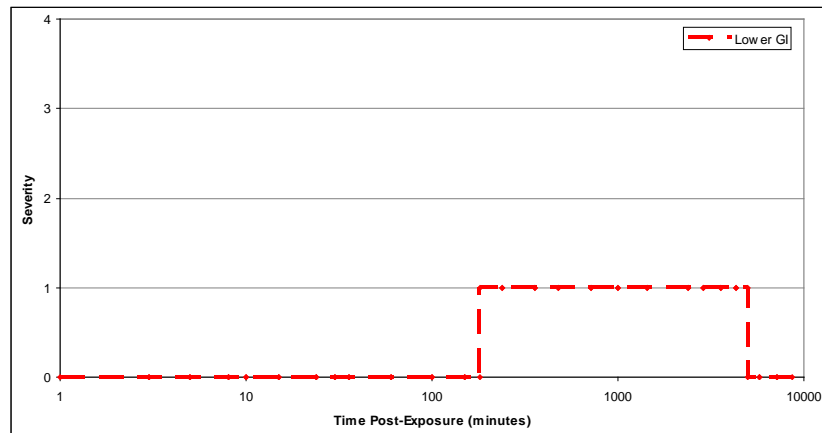


Figure 93. Lower GI Symptom Progression for Percutaneous VX Liquid
Dose Range 1.6 – < 3.9 mg/man*

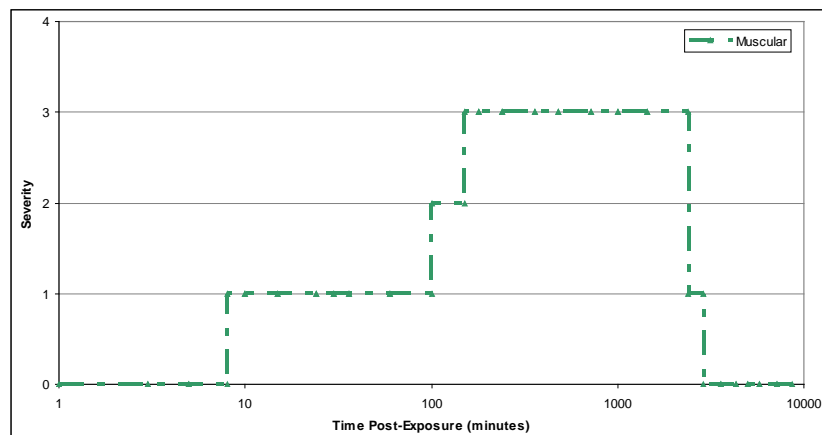


Figure 94. Muscular Symptom Progression for Percutaneous VX Liquid
Dose Range 1.6 – < 3.9 mg/man*

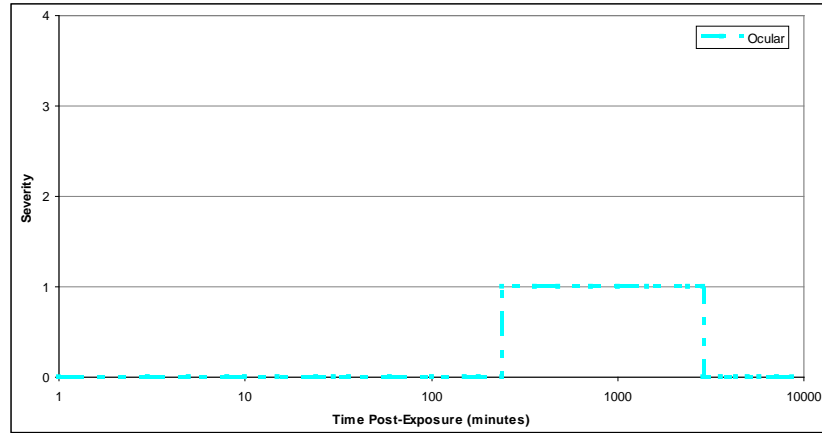


Figure 95. Ocular Symptom Progression for Percutaneous VX Liquid
Dose Range 1.6 – < 3.9 mg/man*

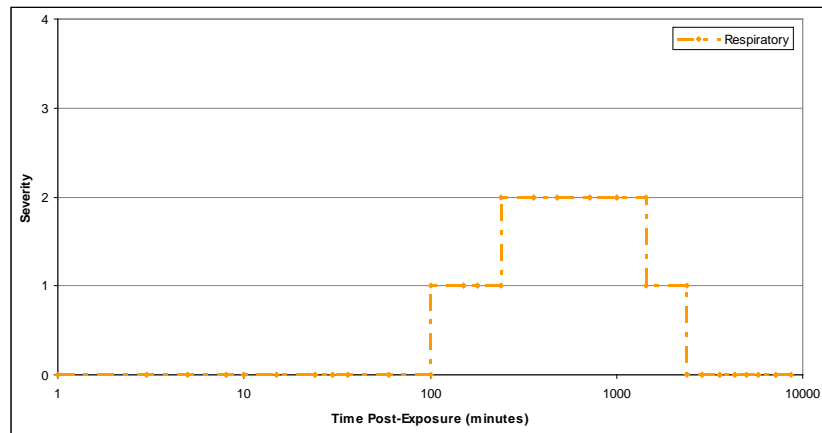


Figure 96. Respiratory Symptom Progression for Percutaneous VX Liquid
Dose Range 1.6 – < 3.9 mg/man*

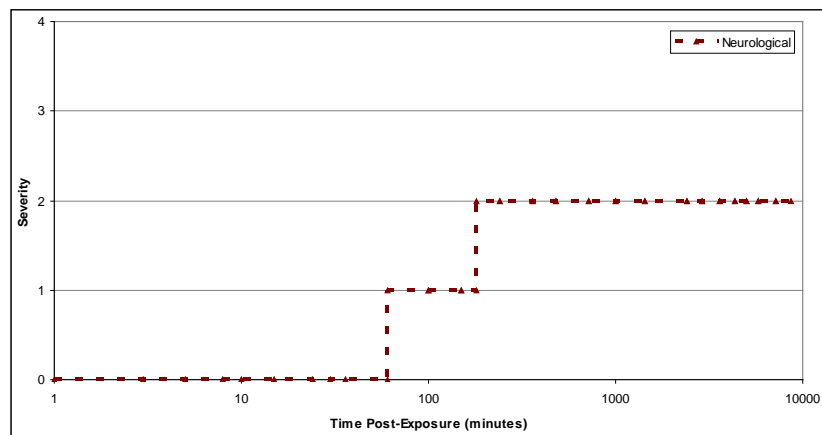


Figure 97. Neurological Symptom Progression for Percutaneous VX Liquid
Dose Range 1.6 – < 3.9 mg/man*

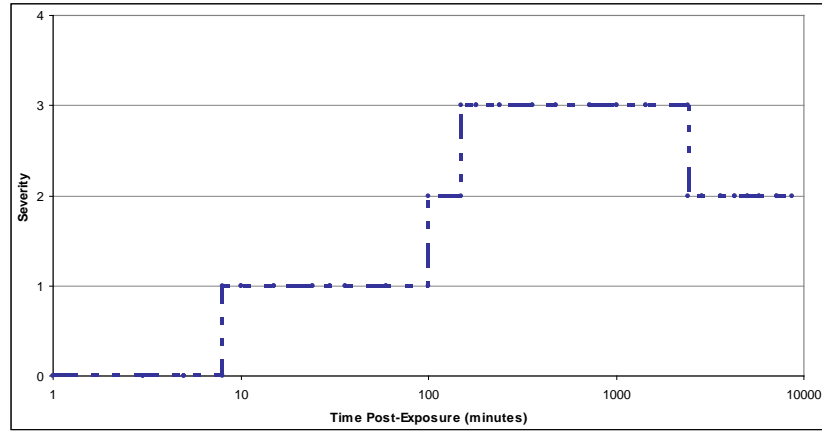


Figure 98. Injury Profile for Percutaneous VX Liquid
Dose Range 1.6 – < 3.9 mg/man*

* Symptom progressions and injury profiles for percutaneous VX were added post NATO SME meeting; progressions and profiles were derived based on literature and recommendations from US SMEs.

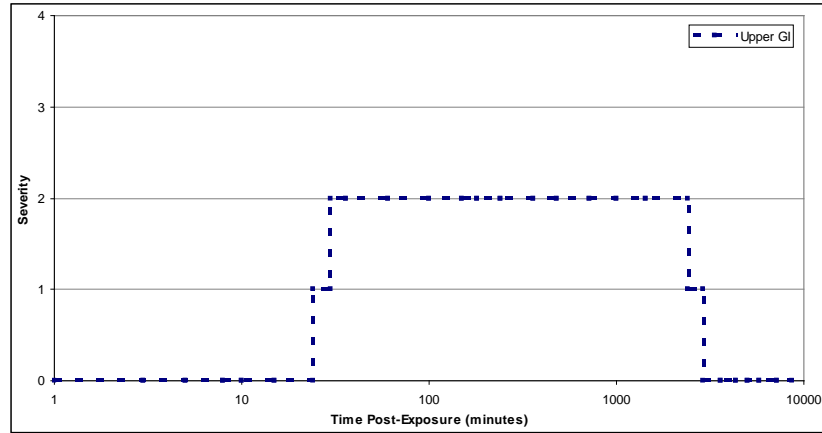


Figure 99. Upper GI Symptom Progression for Percutaneous VX Liquid
Dose Range ≥ 3.9 mg/man*

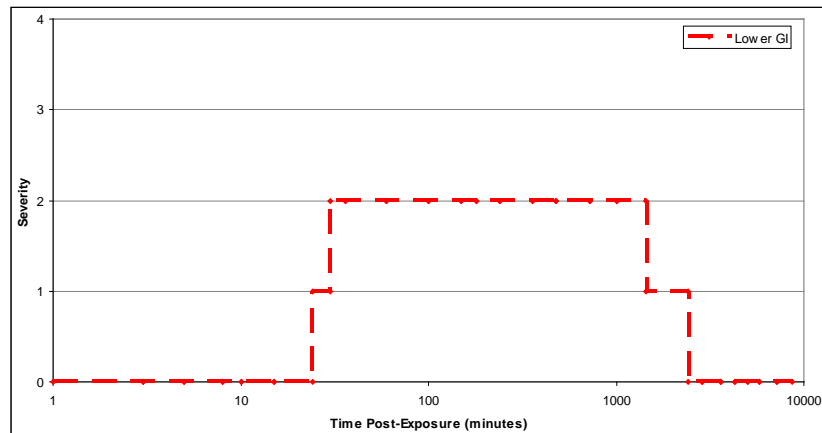


Figure 100. Lower GI Symptom Progression for Percutaneous VX Liquid
Dose Range ≥ 3.9 mg/man*

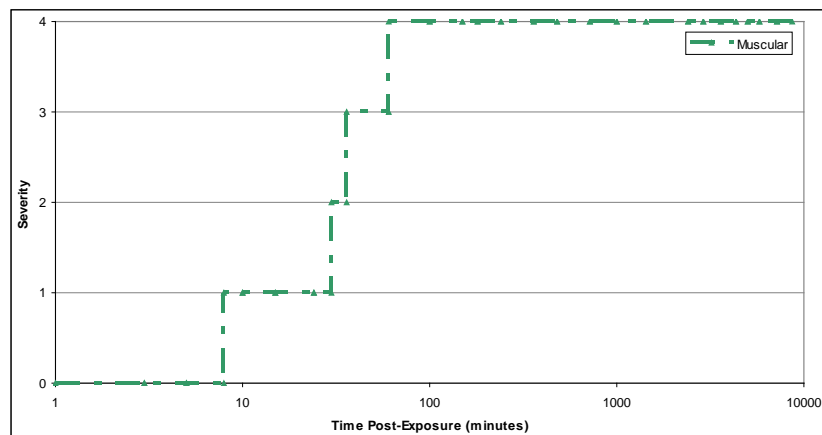


Figure 101. Muscular Symptom Progression for Percutaneous VX Liquid
Dose Range ≥ 3.9 mg/man*

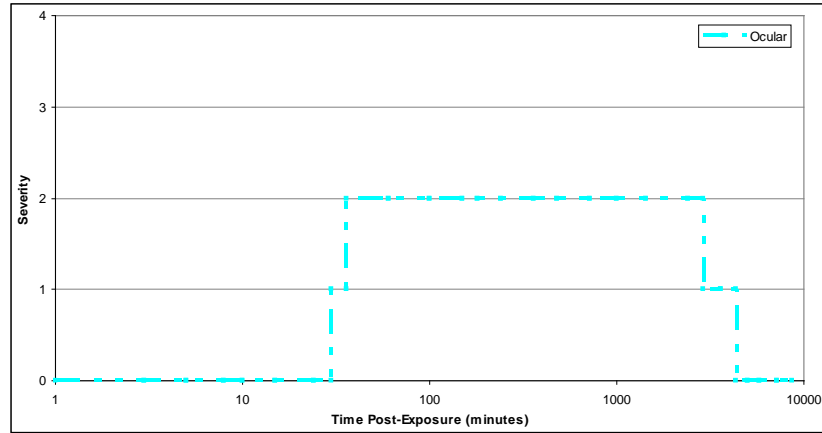


Figure 102. Ocular Symptom Progression for Percutaneous VX Liquid
Dose Range ≥ 3.9 mg/man*

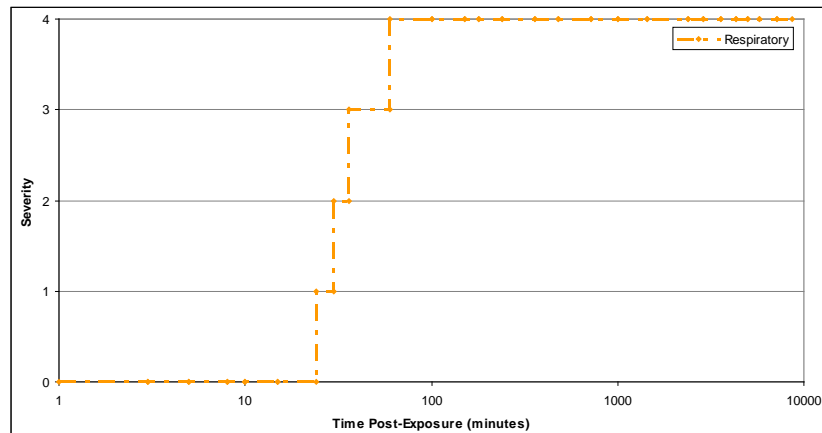


Figure 103. Respiratory Symptom Progression for Percutaneous VX Liquid
Dose Range ≥ 3.9 mg/man*

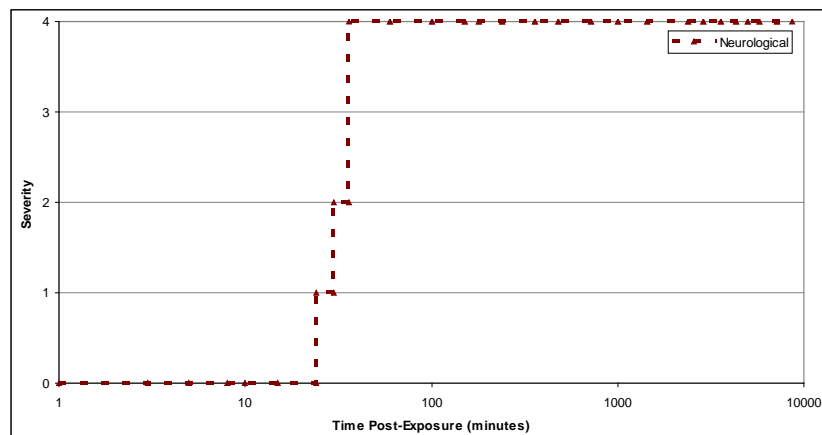


Figure 104. Neurological Symptom Progression for Percutaneous VX Liquid
Dose Range ≥ 3.9 mg/man*

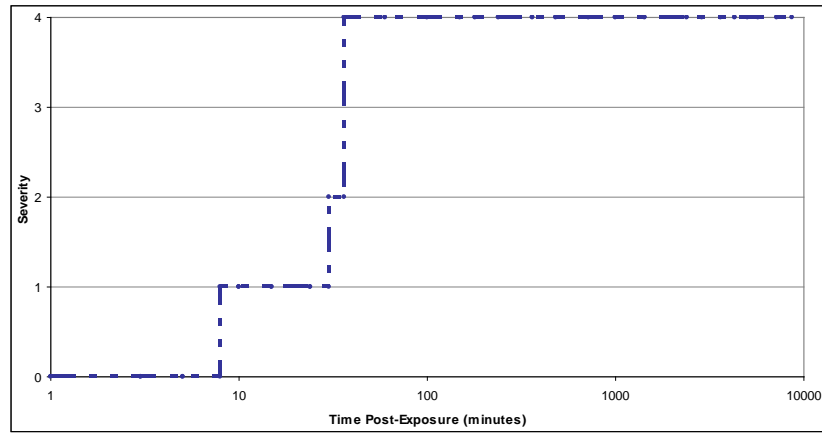


Figure 105. Injury Profile for Percutaneous VX Liquid
Dose Range ≥ 3.9 mg/man*

* Symptom progressions and injury profiles for percutaneous VX were added post NATO SME meeting; progressions and profiles were derived based on literature and recommendations from US SMEs.

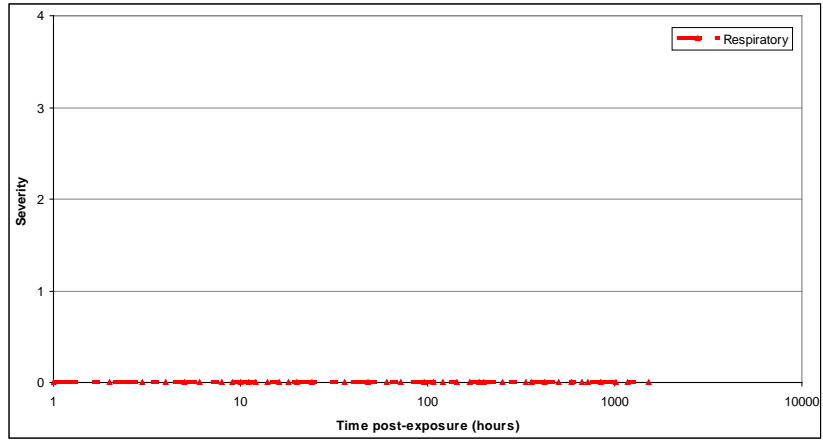


Figure 106. Respiratory Symptom Progression for Inhaled HD Vapor
Dosage Range 50 – < 70 mg-min/m³

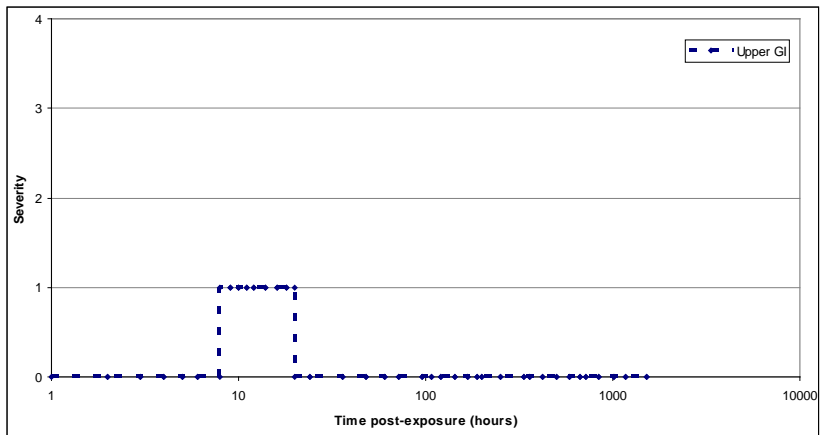


Figure 107. Upper GI Symptom Progression for Inhaled HD Vapor
Dosage Range 50 – < 70 mg-min/m³

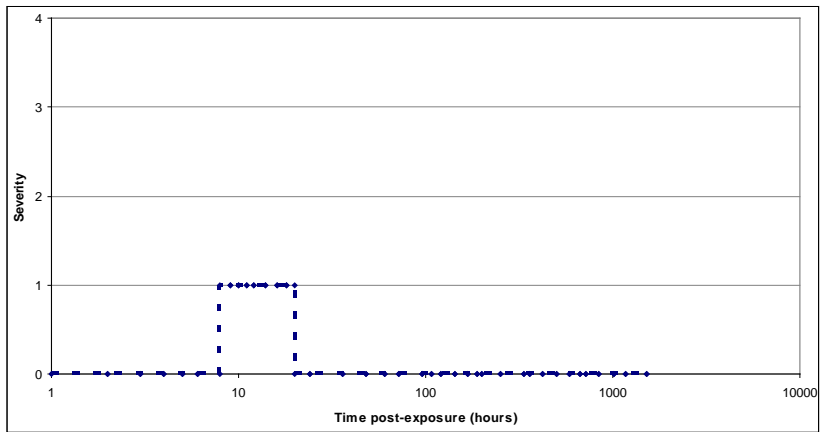
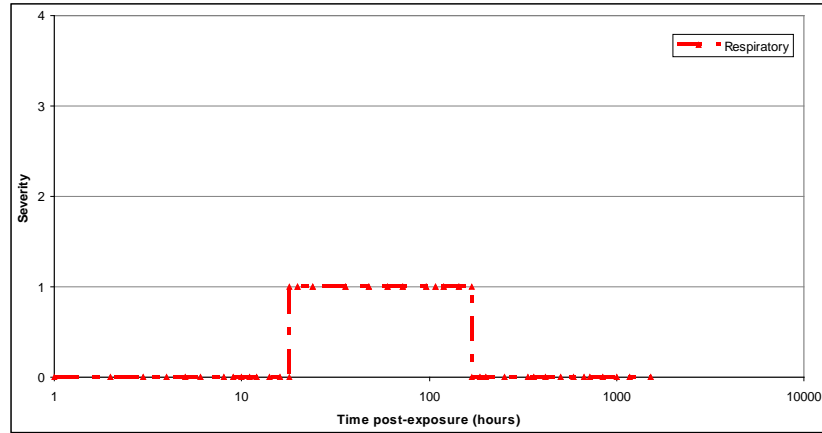
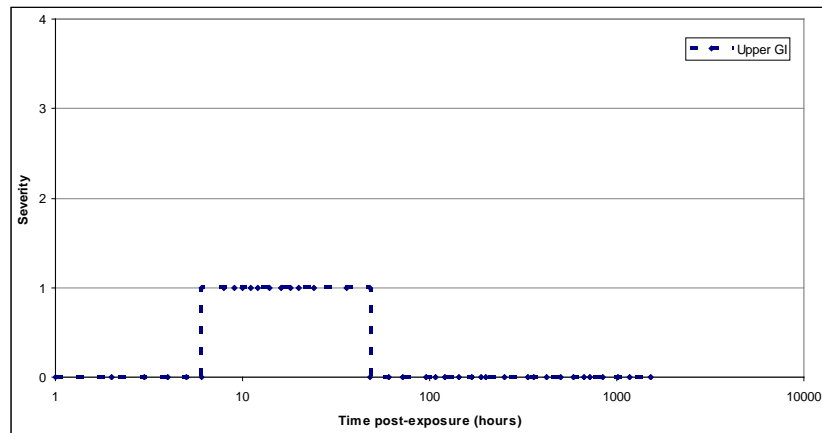


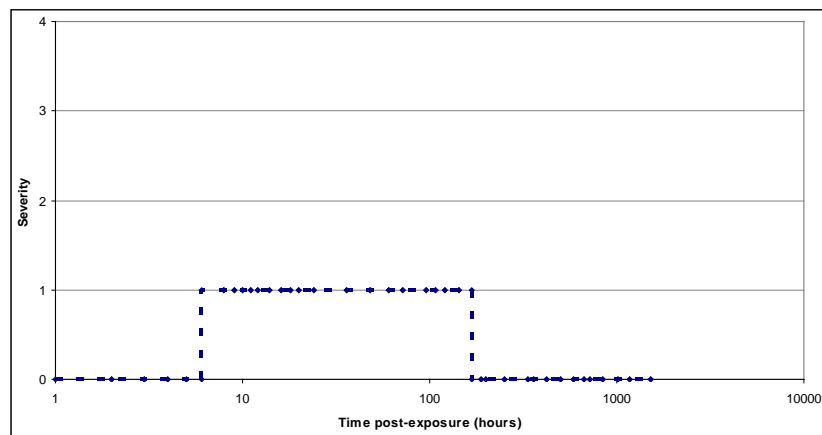
Figure 108. Injury Profile for Inhaled HD Vapor
Dosage Range 50 – < 70 mg-min/m³



**Figure 109. Respiratory Symptom Progression for Inhaled HD Vapor
Dosage Range 70 – < 100 mg-min/m³**



**Figure 110. Upper GI Symptom Progression for Inhaled HD Vapor
Dosage Range 70 – < 100 mg-min/m³**



**Figure 111. Injury Profile for Inhaled HD Vapor
Dosage Range 70 – < 100 mg-min/m³**

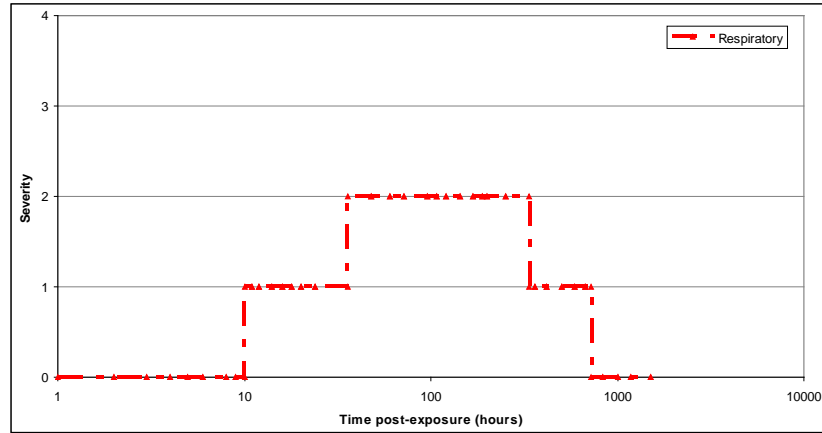


Figure 112. Respiratory Symptom Progression for Inhaled HD Vapor
Dosage Range 100 – < 150 mg-min/m³

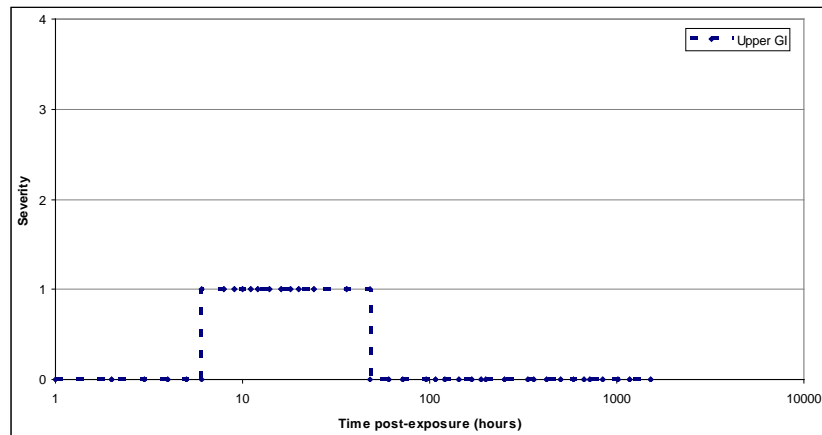


Figure 113. Upper GI Symptom Progression for Inhaled HD Vapor
Dosage Range 100 – < 150 mg-min/m³

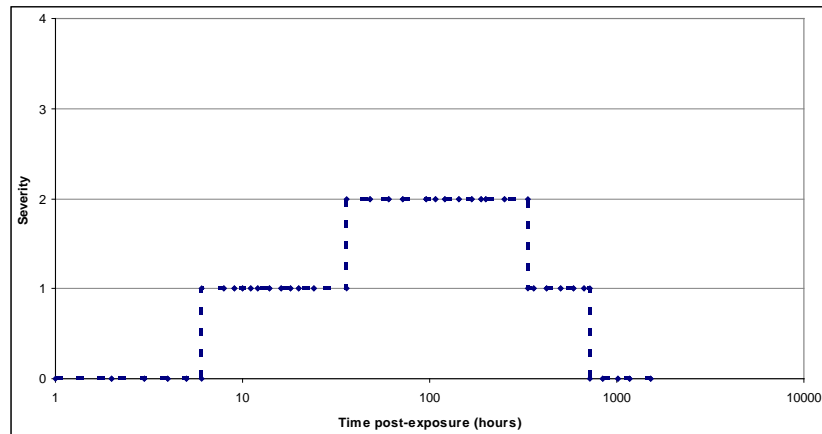


Figure 114. Injury Profile for Inhaled HD Vapor
Dosage Range 100 – < 150 mg-min/m³

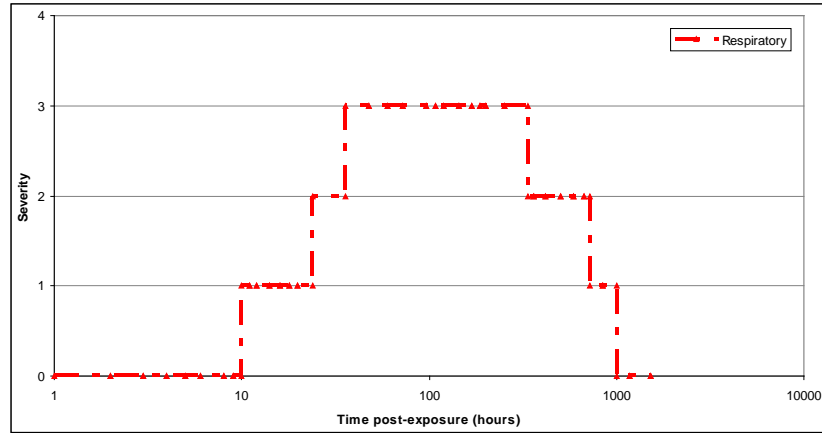


Figure 115. Respiratory Symptom Progression for Inhaled HD Vapor
Dosage Range 150 – < 250 mg-min/m³

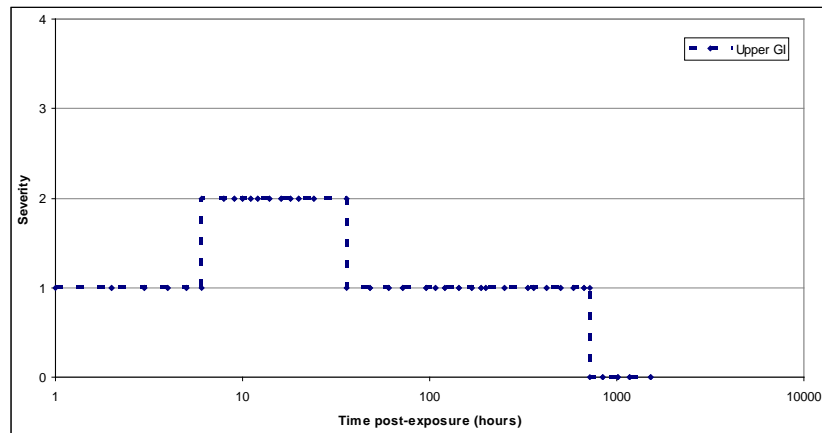


Figure 116. Upper GI Symptom Progression for Inhaled HD Vapor
Dosage Range 150 – < 250 mg-min/m³

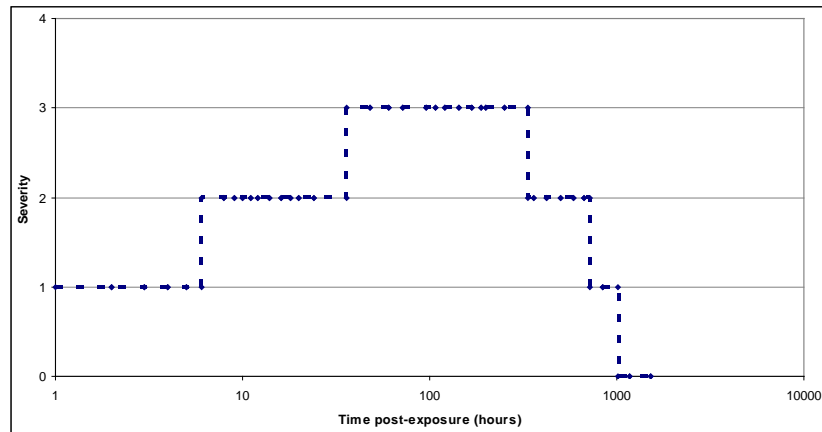


Figure 117. Injury Profile for Inhaled HD Vapor
Dosage Range 150 – < 250 mg-min/m³

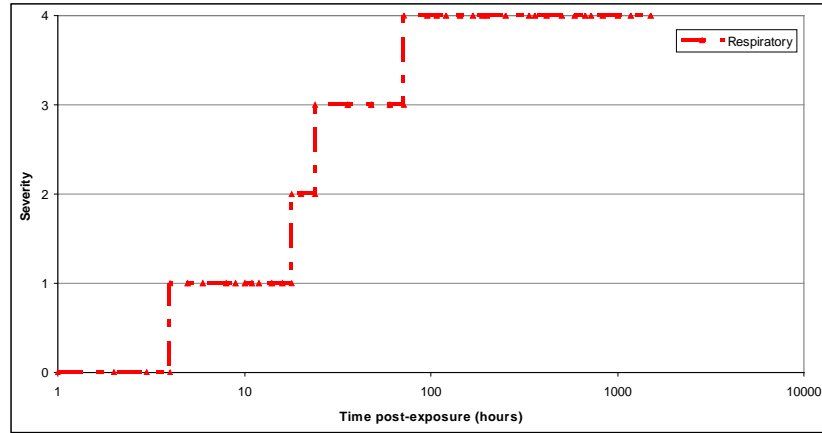


Figure 118. Respiratory Symptom Progression for Inhaled HD Vapor
Dosage Range 250 – < 1200 mg-min/m³

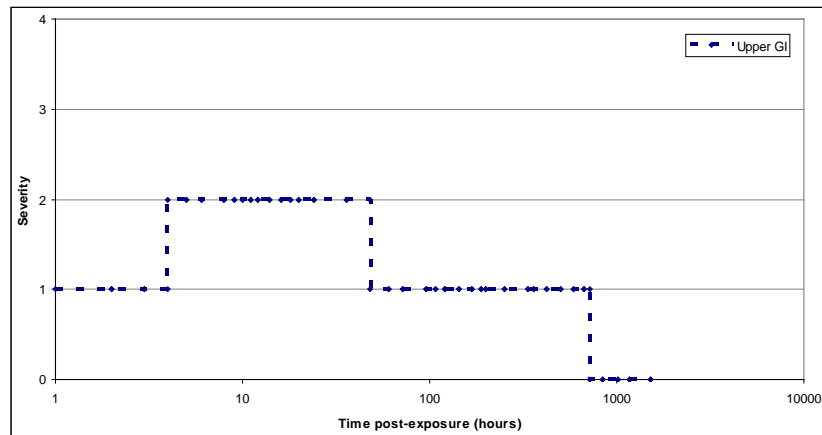


Figure 119. Upper GI Symptom Progression for Inhaled HD Vapor
Dosage Range 250 – < 1200 mg-min/m³

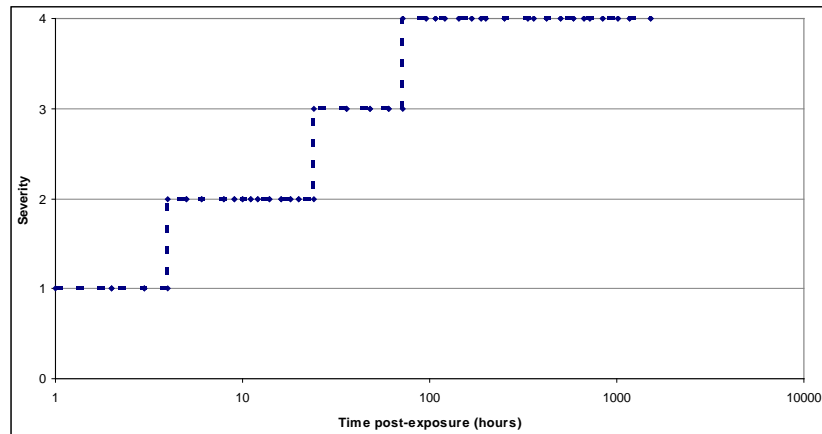


Figure 120. Injury Profile for Inhaled HD Vapor
Dosage Range 250 – < 1200 mg-min/m³

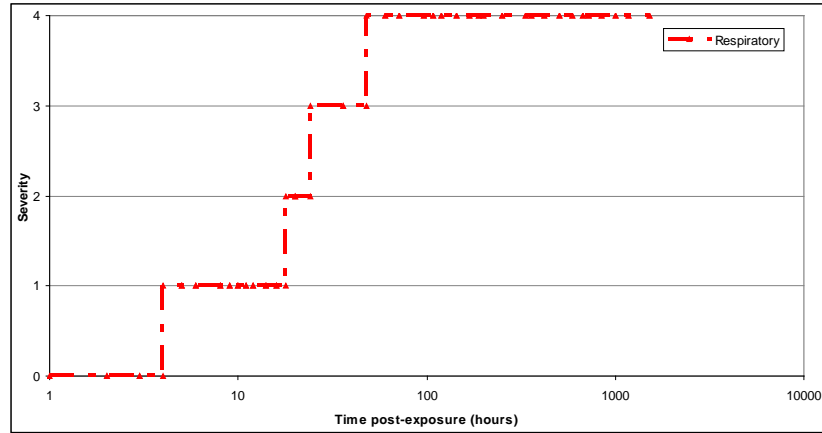


Figure 121. Respiratory Symptom Progression for Inhaled HD Vapor
Dosage Range $\geq 1200 \text{ mg-min/m}^3$

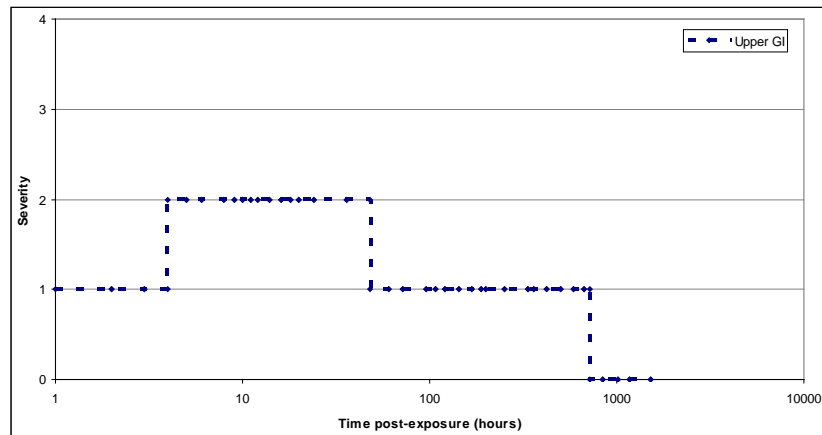


Figure 122. Upper GI Symptom Progression for Inhaled HD Vapor
Dosage Range $\geq 1200 \text{ mg-min/m}^3$

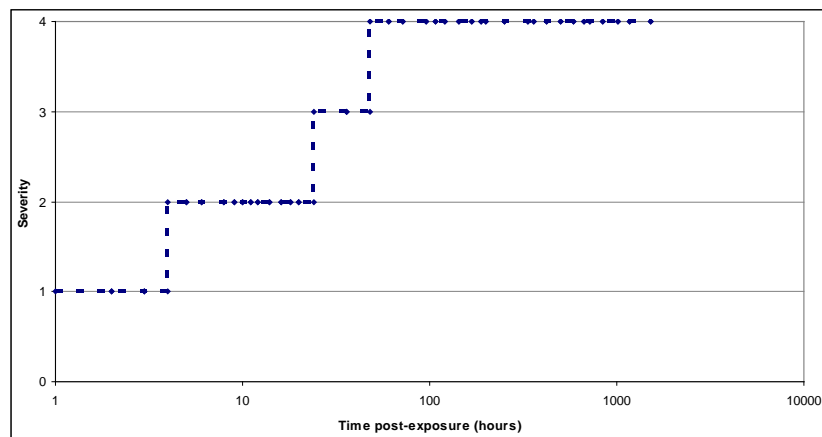


Figure 123. Injury Profile for Inhaled HD Vapor
Dosage Range $\geq 1200 \text{ mg-min/m}^3$

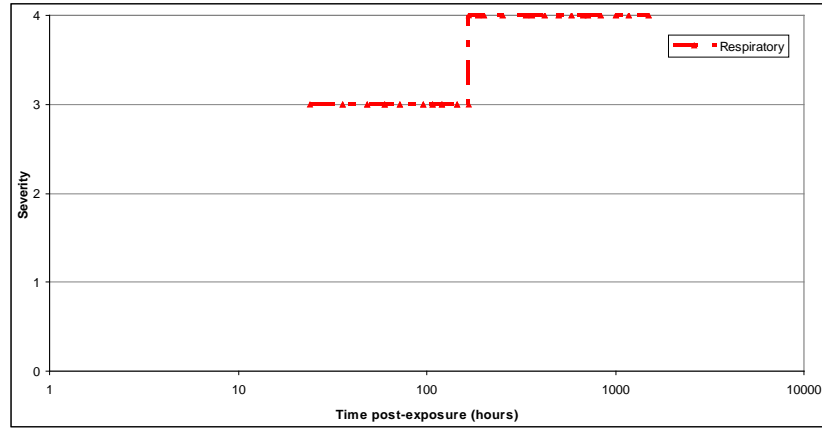


Figure 124. Symptom Progression for Respiratory
Dose Range ≥ 1400 mg/man*

* Dose range and symptom progression added at the recommendation of SMEs to account for the lethal effects of percutaneous HD liquid.

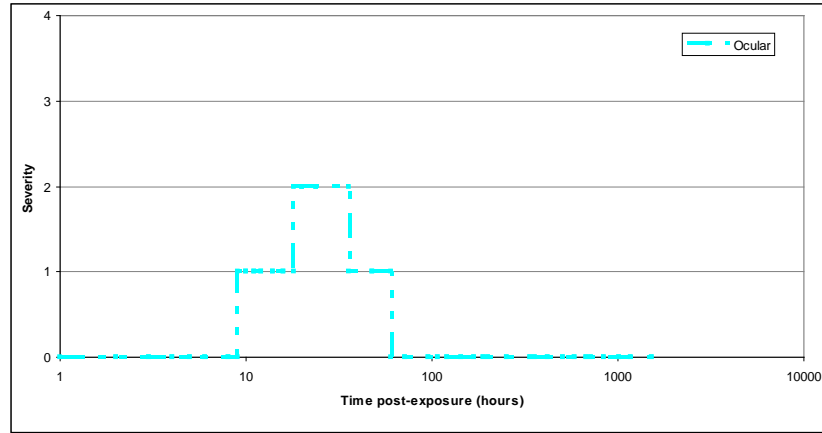


Figure 125. Injury Profile for Ocular HD Vapor
Dosage Range 4 – < 26 mg-min/m³*

* Ocular HD Vapor injury profile follows the Ocular symptom progression.

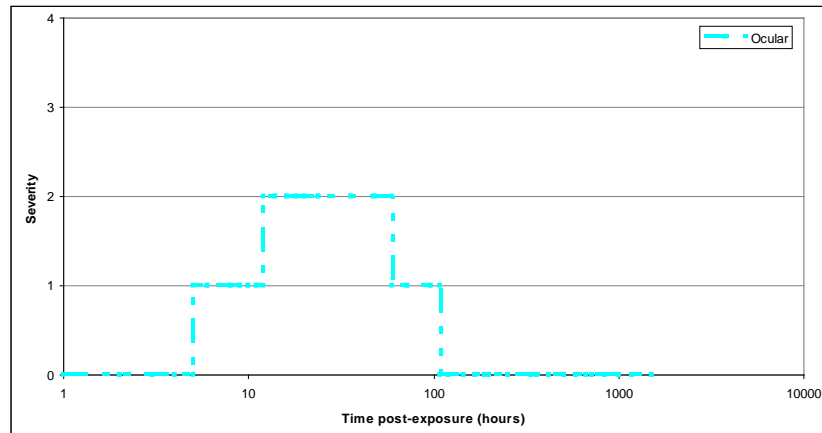


Figure 126. Injury Profile for Ocular HD Vapor
Dosage Range 26 – < 50 mg-min/m³*

* Ocular HD Vapor injury profile follows the Ocular symptom progression.

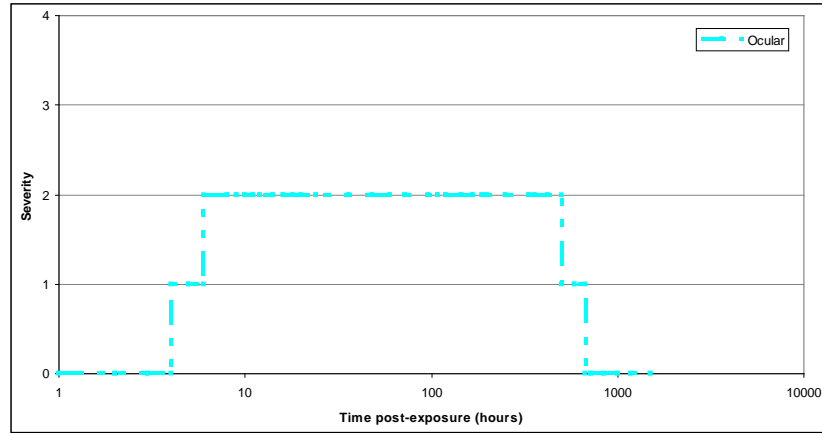


Figure 127. Injury Profile for Ocular HD Vapor
Dosage Range 50 – < 70 mg-min/m³*

* Ocular HD Vapor injury profile follows the Ocular symptom progression.

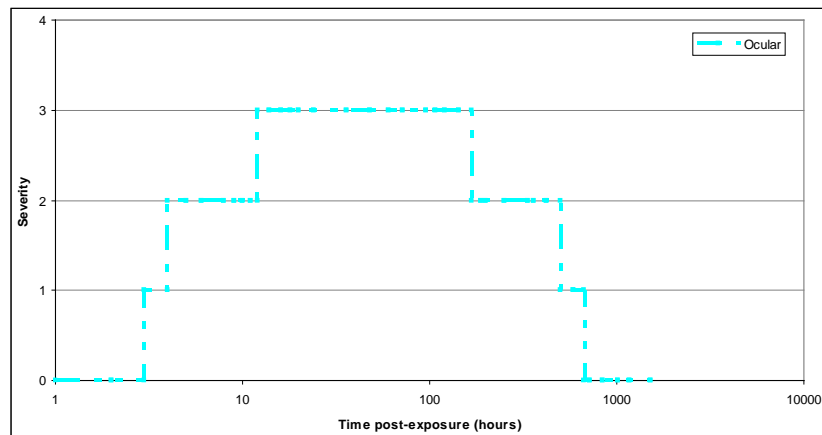


Figure 128. Injury Profile for Ocular HD Vapor
Dosage Range 70 – < 100 mg-min/m³*

* Ocular HD Vapor injury profile follows the Ocular symptom progression.

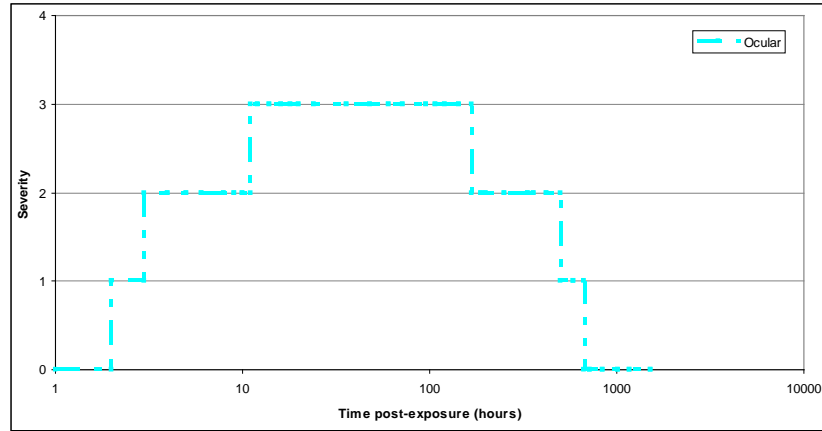
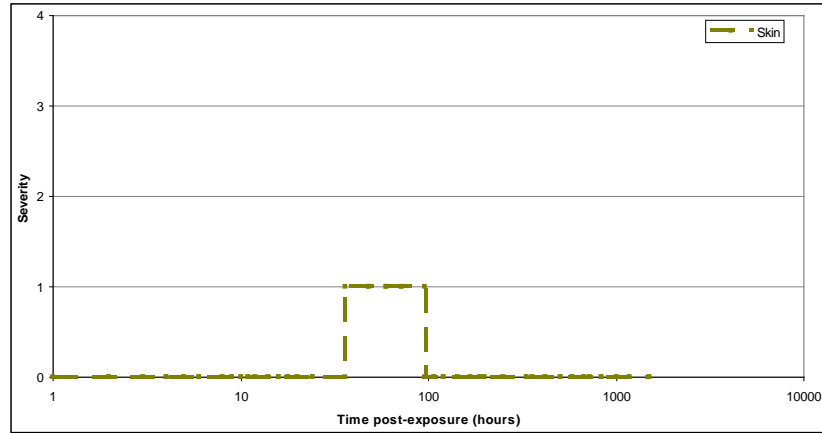


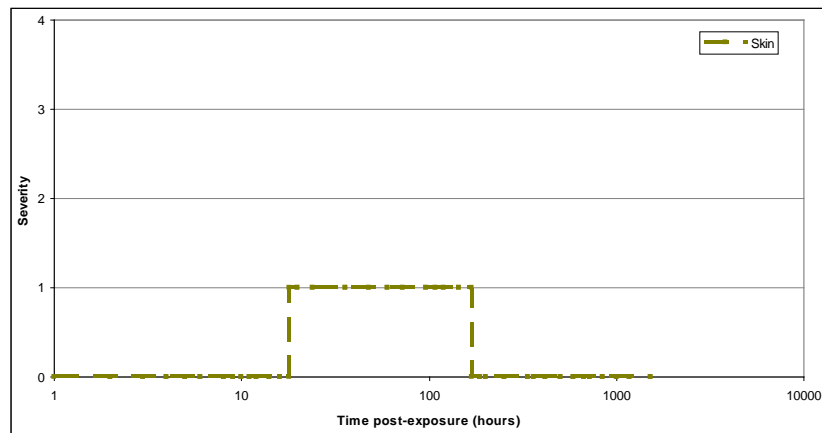
Figure 129. Injury Profile for Ocular HD Vapor
Dosage Range $\geq 100 \text{ mg-min/m}^3$ *

* Ocular HD Vapor injury profile follows the Ocular symptom progression.



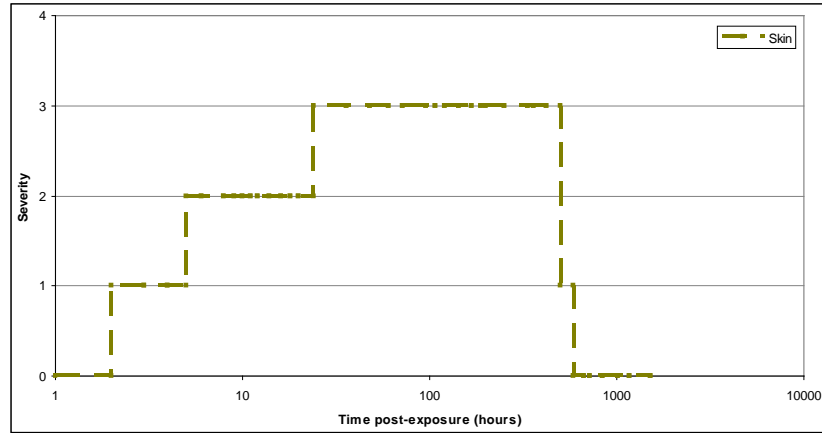
**Figure 130. Injury Profile for Equivalent Percutaneous
HD Vapor Dosage Range 12 – < 125 mg/man***

* Equivalent Percutaneous HD Vapor injury profile follows the Skin symptom progression.



**Figure 131. Injury Profile for Equivalent Percutaneous
HD Vapor Dosage Range 125 – < 180 mg/man***

* Equivalent Percutaneous HD Vapor injury profile follows the Skin symptom progression.



**Figure 132. Injury Profile for Equivalent Percutaneous
HD Vapor Dosage Range ≥ 180 mg/man***


* Equivalent Percutaneous HD Vapor injury profile follows the Skin symptom progression.

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II. BRIEFINGS

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A. Chemical Human Response Review Overview and Objectives – *Briefing*




Allied Medical Publication 8 (AMedP-8) SD.3 2008
Medical Planning Guide for CBRN Casualty Estimation
Subject Matter Expert Meeting – Chemical Human Response Models

***AMedP-8(C) NATO Planning Guide for the
Estimation of CBRN Casualties***

**Chemical Human Response Review
Overview and Objectives**

MAJ Kevin Hart
US Army
Office of the Surgeon General
21 April 2008



Meeting Objective

- To develop agreement within NATO on:
 - The proposed concept for modeling human response to chemical agents in AMedP-8
 - Chemical toxicity data used in the models
 - Outputs of the model
 - Numbers of KIA, WIA, DOW over time
 - Disease severity over time for WIA
 - SD.3 objectives and desired outputs

21 April 20081



AMedP-8(C) Purpose

- To provide a methodology for estimating casualties occurring as a consequence of chemical, biological, radiological or nuclear (CBRN) attacks against Allied targets, military or civilian, to support the NATO medical planning process. The methodology is designed to provide estimates of time dependence of the incidence of symptoms by type and severity, numbers of casualties, to include numbers of fatalities.

21 April 2008

2



AMedP-8 (C) Background

- Part of series of Allied Medical Publications for NBC Planning and Response
 - AMedP-6(C), NATO Handbook on the Medical Aspects of NBC Defensive Operations
 - Treatment and Medical Management at the Physician – Patient level
 - AMedP-7(D), Concept of Operations for Medical Support in NBC Environments
 - Medical Management at the Unit/Operational Level
 - AMedP-8(B), Medical Planning Guide of NBC Battle Casualties
 - Casualty estimation at the Unit/Operational Level

21 April 2008

3



Draft Development Process

- SD.1 – Outline of proposed document
- SD.2 – Description of methodology up to point of individual estimate of exposure
 - Algorithms and required parameters for components other than human response models
- SD.3 – Complete description of methodology, to include human response to CBRN agents and insults
 - Algorithms and required parameters for human response models
 - Casualty estimation methodology
- Connect to Casualty Estimation Tool
 - Provide input to NATO conventional casualty estimation tools
 - Provide additional capabilities to Nations, as necessary (unsupported)
- Technical Reference
 - Reference documentation available to NATO

21 April 2008

4



Current Efforts

- STANAG 2476, Ed 2, Addendum to AMedP-8(B)
 - Ratified and promulgated 20 Dec 2007
- Development of Study 2553, Ed 1, AMedP-8(C) SD.3 - NATO Planning Guide For The Estimation Of CBRN Casualties (new version)
 - SD.2 distributed October 2007
 - SD.3 under development

21 April 2008

5



AMedP-8(C) Study Timeline

- SD.3 (Describe algorithms and required parameters for human response models)
 - Custodial Meetings--review technical aspects of modeling human response with national Subject Matter Experts
 - **21-22 April 2008, Chemical agents (Munich, in conjunction with German Medical Chemical Conference)**
 - 8-9 May 2008, Biological agents (San Lorenzo de El Escorial, in conjunction with 21st BioMedAC)
 - 23-27 June 2008, Nuclear effects & Radiological agents (Albuquerque, New Mexico)
 - September 2008, "Virtual Custodial Meeting" for final pre-coordination review of CBRN casualty estimation (by correspondence)
 - November 2008, Publish SD.3 for review
 - February 2009, Custodial Meeting in conjunction with CBRNMedWG Meeting to adjudicate SD.3 comments and discuss input to NATO conventional casualty estimation tools (Brussels)

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Agenda - Monday, April 21, 2008

1300-1330

Meeting Overview and Objectives, Introductions, MAJ Kevin Hart

1330-1430

General Human Response Modeling Concept, Dr. Carl Curling

- Proposed Procedure
- General Signs and Symptoms Maps
- Definitions (i.e. casualty, fatality)

1430-1500

Illustrative Example, Dr. Robert Zirkle

1500-1530 *Coffee Break*

1530-1700

Nerve Agent Toxicity and Correlation of Dose, Ms. Deena Disraelly

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Agenda - Tuesday, April 22, 2008

0900-1030

Nerve Agent Response: Signs and Symptoms Over Time as a Function of Dose,
Dr. Robert Zirkle

1030-1100 *Coffee Break*

1100-1200

Introduction to HD (Mustard) Agent Signs and Symptoms and Equivalent Dose,
Ms. Deena Disraelly

1200-1330 *Lunch*

1330-1500

HD (Mustard) Response: Signs and Symptoms Over Time as a Function of
Dose, Dr. Carl Curling

1500-1530 *Coffee Break*

1530-1630

Chemical Agent Casualty Profiles, Dr. Carl Curling

1630-1700

Review, Conclusions, and Way Ahead, MAJ Kevin Hart

1700 *Adjourn*

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Subject Matter Expert Meeting – Chemical Human Response Models

Questions?



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B. General Human Response Modeling Concept – Briefing

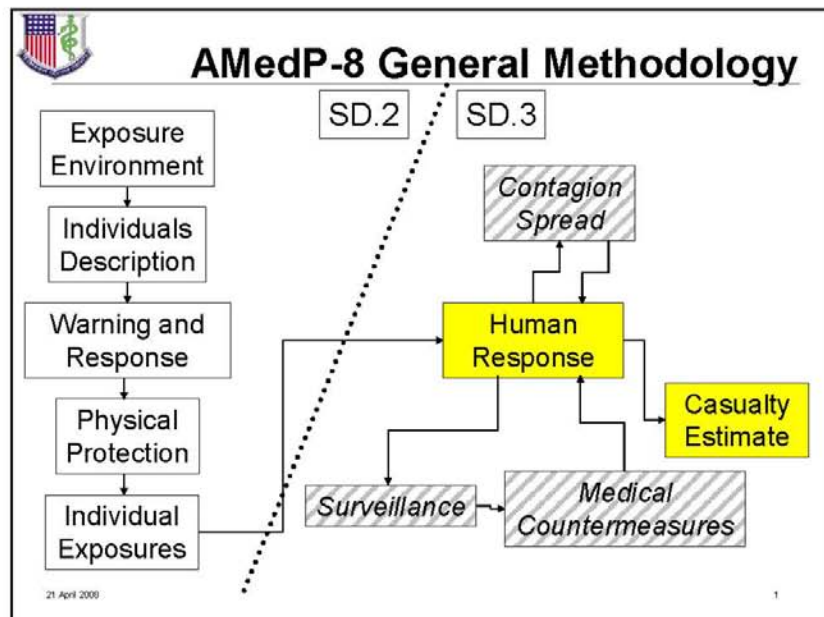


Allied Medical Publication 8 (AMedP-8) SD.3 2008
Medical Planning Guide for CBRN Casualty Estimation
Subject Matter Expert Meeting – Chemical Human Response Models

**AMedP-8(C) NATO Planning Guide for the
Estimation of CBRN Casualties**

**General Human Response
Modeling Concept**

Carl A. Curling
Julia Burr
Lusine Danakian
Deena Disraeli
Robert Zirkle
Institute for Defense Analyses
21 April 2008





AMedP-8 Human Response Models

- The proposed Human Response Models:
 - Are described by disease profile maps which are based upon disease progression maps, or signs/symptom severities over time
 - Allow for estimation of:
 - KIA as a function of specific levels of effect
 - WIA at the time at which signs, symptoms and/or illness reach a specified severity level or as a function of specific effect levels
 - DOW at some time after agent or effect exposure as a function of an agent/effect-related estimation or a specified severity level

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AMedP-8 Human Response Models

- Estimates the status over time of personnel exposed to some Chemical, Biological, Radiological, or Nuclear agent or effect
- Estimates the number of people who:
 - May be expected to require medical treatment
 - Are anticipated KIA, WIA, and DOW due to the agent or effect exposure
- Does NOT anticipate the number of people who:
 - May seek medical assistance (Battle Stress)
 - May be injured or killed indirectly (i.e. as a result of car accidents, dehydration, heart attacks, etc).

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AMedP-8 Working Definitions

- **Human response model** (also known as a casualty estimation model)
 - Usually one component of a larger suite of models
 - Used to estimate status over time of personnel exposed to some event involving CBRN agents.
 - The model does not anticipate the number of people who may seek medical assistance or the number who may be injured or killed indirectly (i.e. as a result of car accidents, dehydration, heart attacks, etc).
- **Casualty**
 - "In relation to personnel, any person who is lost to his organization by reason of having been declared dead, wounded, diseased, detained, captured or missing." (AAP-6)
- **Chemical casualty**
 - "Any person who is lost to his organization by reason of having been declared dead, wounded or diseased as a result of exposure to a chemical agent." (AMedP-13)
- **Disease**
 - An internal disruption of organ or system function, not caused by external trauma.
 - **Disease casualty**
 - "Any person who is lost to an organization by reason of any deviation from, or interruption of, the normal structure or function of any part, organ, or system (or combination thereof) of the body that is not caused by external trauma, that is manifested by a characteristic set of symptoms and signs and whose etiology, pathology, and prognosis may be known or unknown." (AMedP-13)

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Definitions from NATO documents: AMedP-8(C), AAP-6, and AMedP-13. 4



AMedP-8 Working Definitions

- **Killed in Action**
 - "A battle casualty who is killed outright or who dies as a result of wounds or other injuries before reaching a medical treatment facility." (AAP-6)
 - Based on conversations with NATO CBRN Medical Working Group participants, individuals will be assessed as KIA if their disease progression (or other method of calculation) suggests that they would express exposure effects resulting in imminent danger to life for at least 15 minutes before 30 minutes post-exposure.
- **Wounded in Action**
 - "A battle casualty other than "killed in action" who has incurred an injury [or disease] due to an external agent or cause. The term encompasses all kinds of wounds and other injuries incurred in action, whether there is a piercing of the body, as in a penetrating or perforated wound, or none, as in the contused wound; all fractures, burns, blast concussions, all effects of biological and chemical." (AAP-6)
- **Died of Wounds**
 - "A battle casualty who dies of wounds [or disease] or other injuries received in action, after having reached a medical treatment facility." (AAP-6)

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Definitions from NATO documents: AMedP-8(C), AAP-6, and AMedP-13. 5



SD.3 Fundamental Concept

- An individual is considered a casualty at the time of first onset of illness/injury-specific signs/symptoms at a specified severity level.

*If (Severity at time $t \geq$ Effects Severity Level)
for any subset of symptoms at time t ,
Then the individual is a casualty (WIA) at time t*

- AMedP-8 specifies the symptoms over time that are used to determine whether an individual is declared dead, wounded, or diseased and thereby considered to be a casualty.
- The nature of symptoms and their times of onset depend on the agent.

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SD.3 Development Process

- Step 1: Identification of CBRN agents and effects and applicable routes of exposure
- Step 2: Identification of appropriate systems, signs & symptoms for each agent and effect
- **Step 3: With the assistance of SMEs, validate signs and symptoms maps for each agent and effect**
- Step 4: Determine the applicable estimation values:
 - Effects levels resulting in KIA
 - Signs and symptoms severity associated with WIA
 - Dose/Effects-related algorithms and/or signs and symptoms severities likely to result in DOW

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Severity Definitions

- No Observable Effect ≈ Severity = 0
- Mild ≈ Severity = 1
- Moderate ≈ Severity = 2
- Severe ≈ Severity = 3
- Very Severe ≈ Severity = 4

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Severity Definitions

Degrees		Description
0	N.O.E.	No observable effect
1	Mild	Disease or wounds manifesting signs and symptoms of such severity that individuals can care for themselves or be helped by untrained personnel and their ability to conduct the assigned mission may or may not be impacted by the manifested signs and symptoms.
2	Moderate	Disease or wounds manifesting signs and symptoms of such severity that medical care may be required; general condition permits treatment as outpatient and some continuing care and relief of pain may be required before definitive care is given; condition may be expected to interrupt or preclude ability to conduct the assigned mission.
3	Severe	Disease or wounds manifesting signs and symptoms of such severity that there is cause for immediate concern but there is no imminent danger to life; individual is acutely ill and likely requires hospital care. Indicators are questionable – condition may or may not reverse without medical intervention; individual is unable to conduct the assigned mission due to severity of signs and symptoms.
4	Very Severe	Disease or wounds manifesting signs and symptoms of such severity that life is imminently endangered. Indicators are unfavorable – condition may or may not reverse even with medical intervention; prognosis is lethality without medical intervention; individual is unable to conduct the assigned mission and is unexpected to return to the mission due to severity of signs and symptoms.



Overarching Model Assumptions

- Human response can be modeled over time as a function of dose-related effects (signs and symptoms).
 - Dose-related effects apply for all doses in a specified dose range.
- Human response to an exposure can be represented by the median individual in each dose/dosage/exposure band.
- Toxic Load Exponent = 1; Haber's Law applies.
 - Human response to cumulative dosages/doses (regardless of exposure length in the exposure models) is the function of 2-min exposures.
 - Individual disease profiles begin after completion of exposure, as expressed in the exposure model.
- Prior to exposure, individuals are in perfect health.
- 70 kilogram man, breathing 15 liters per minute.

Additional agent specific assumptions will be discussed by agent

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Model Limitations

- The model cannot address several types of casualties.
 - The model does not address psychological casualties.
 - Secondary casualties and secondary infections/diseases are not modeled.
- Medical countermeasures and medical treatments are not addressed – all disease progressions assume no medical intervention.
- Toxic load is not considered.

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Model Strengths & Weaknesses

- Model represents both the personnel status and disease progression and flow over time.
 - Planners can select and collate data as desired.
- Model allows the user to determine the severity level at which effects are expected to cause WIA.
- Model is deterministic and based on the median individual.
 - It does not allow for variations of dose-response as might be expected in an actual population.
- Much of the model is based on data which is ten or more years old.
 - Additional review with SMEs may be required to determine if more recent research would change proposed disease progressions.

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Medical Planning Guide for CBRN Casualty Estimation
Subject Matter Expert Meeting – Chemical Human Response Models

Questions?



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C. Illustrative Example – *Briefing*

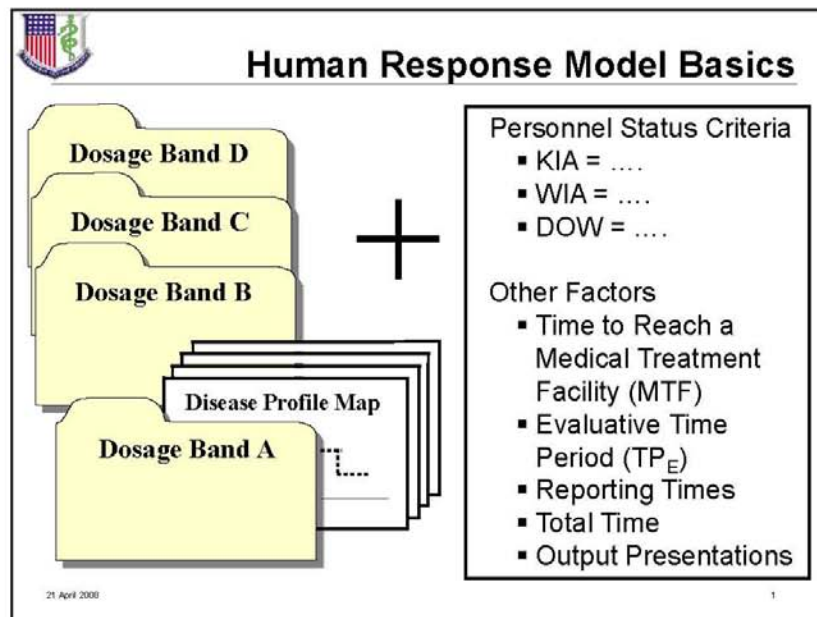


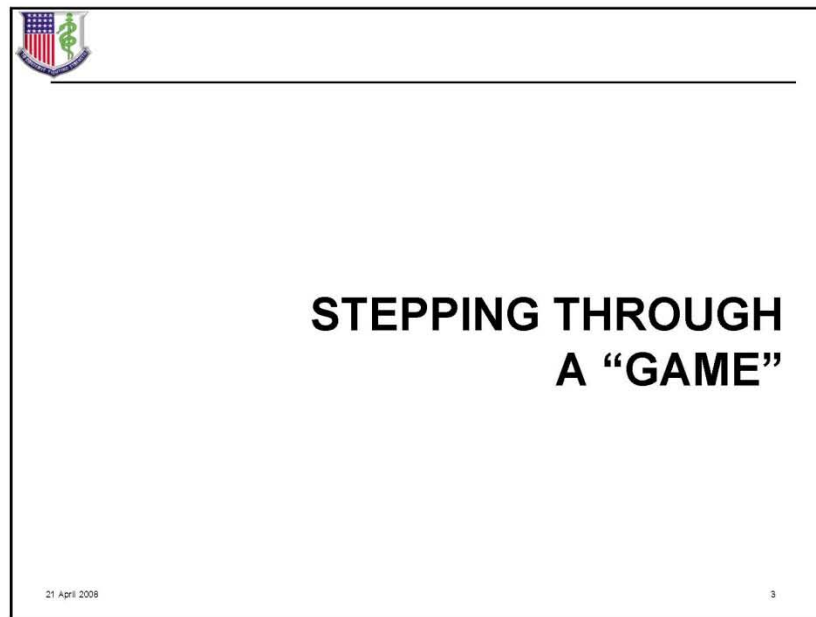
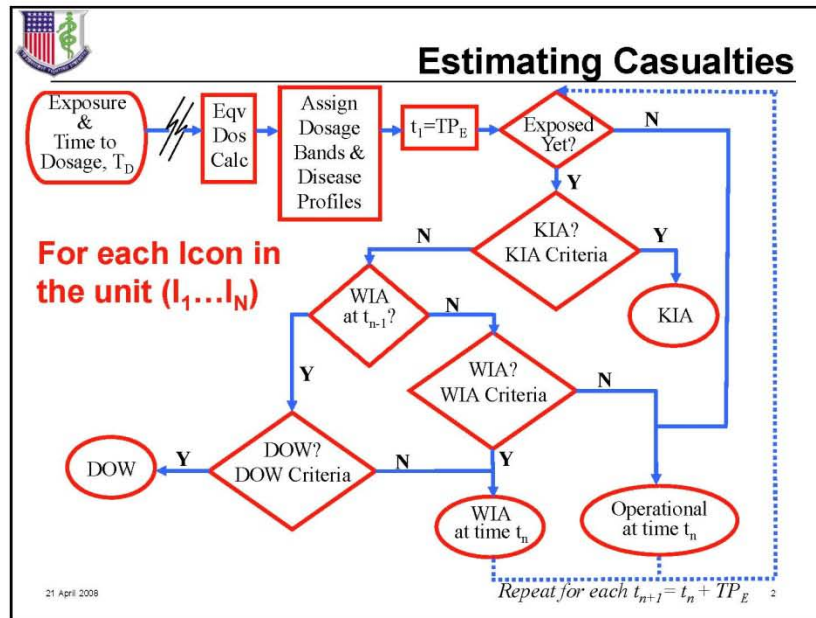
Allied Medical Publication 8 (AMedP-8) SD.3 2008
Medical Planning Guide for CBRN Casualty Estimation
Subject Matter Expert Meeting – Chemical Human Response Models

**AMedP-8(C) NATO Planning Guide for the
Estimation of CBRN Casualties**

Illustrative Example

Bob Zirkle
Carl Curling
Deena Disraelly
Institute for Defense Analyses
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Illustrative Example: User Defined Parameters

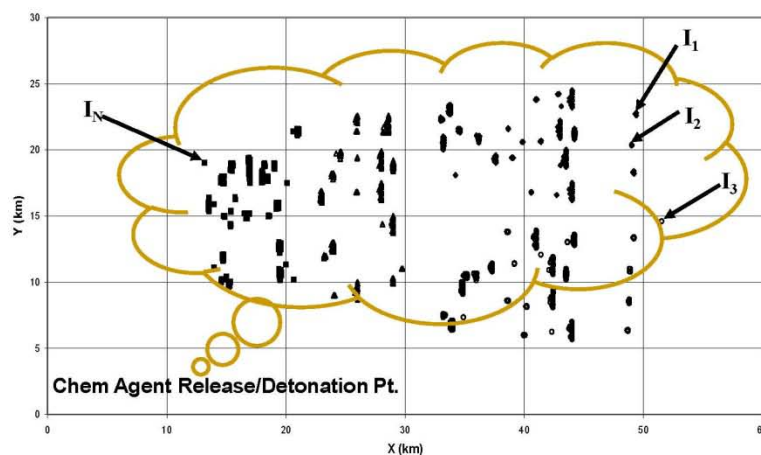
- Time to Reach an MTF = **30 minutes**
- Evaluative Time Period (TP_E) = **15 minutes**
- KIA = Severity Level **4** for **15 minutes** within first **30 minutes** of the “game”
- WIA = Severity Level **2**
- DOW = WIA and Severity Level **4** at **two** consecutive time periods
- Reporting Times = **1st 15 minutes, 1st hour, 1st day, 2nd day....**
- Total Time = **6 days**

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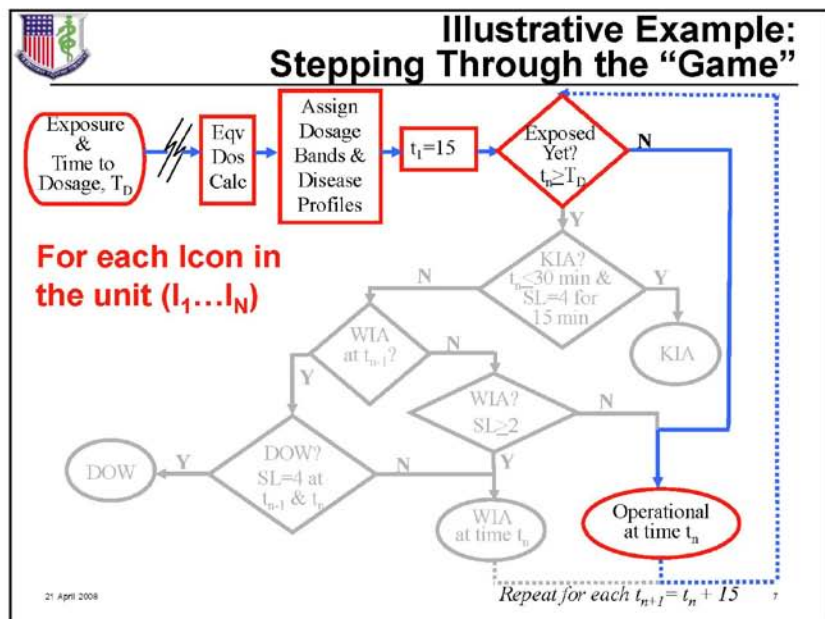
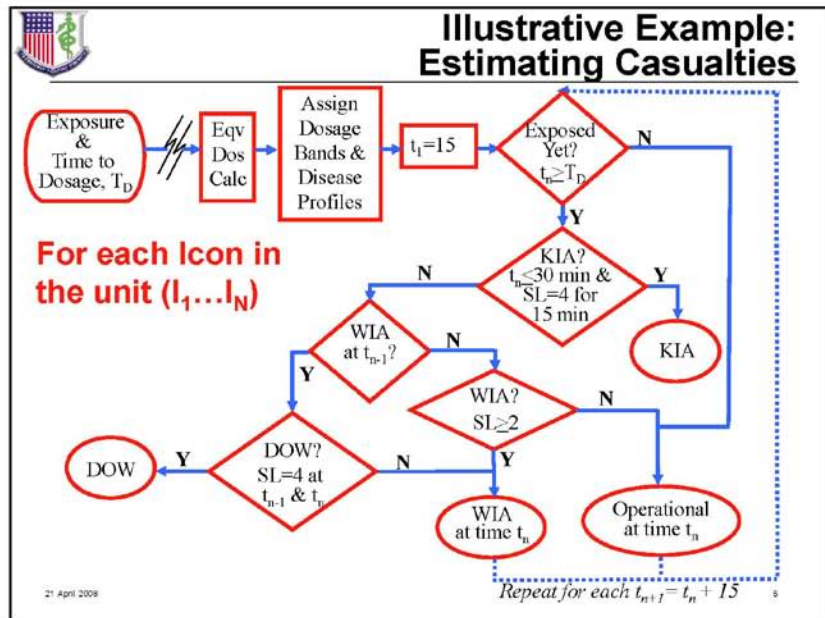


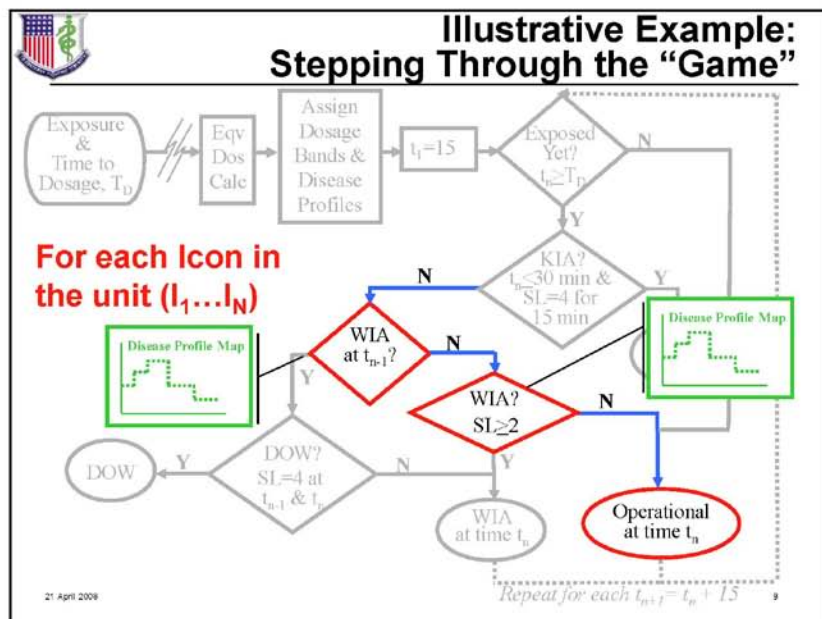
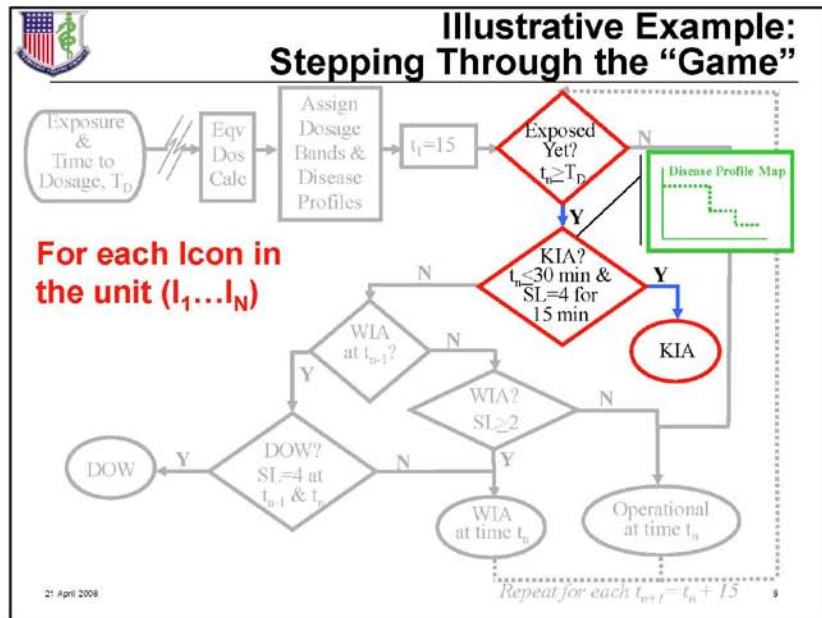
Illustrative Example: Unit Laydown and Attack

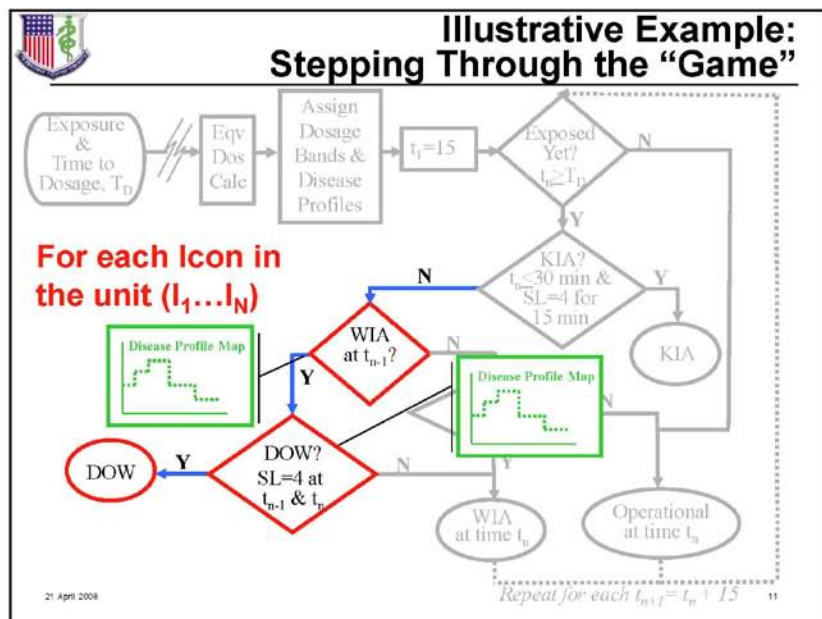
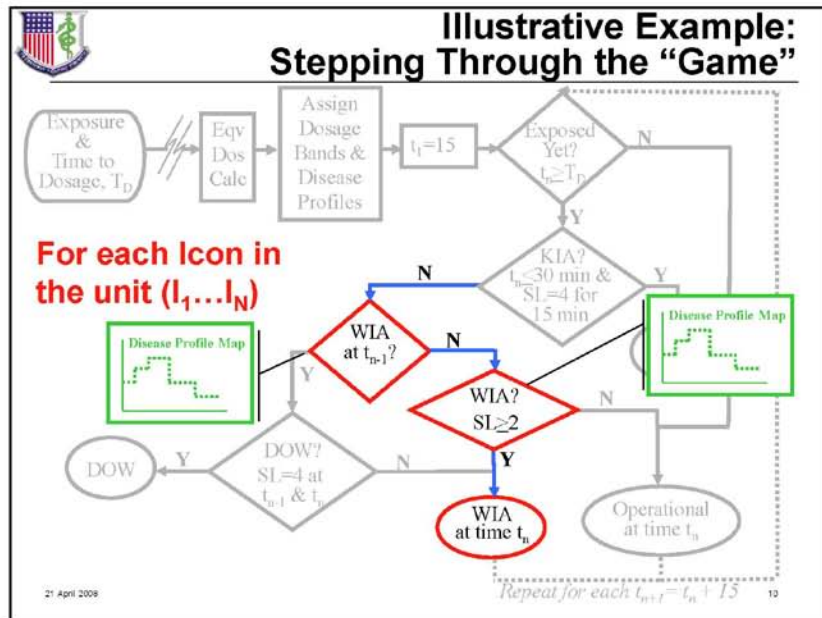


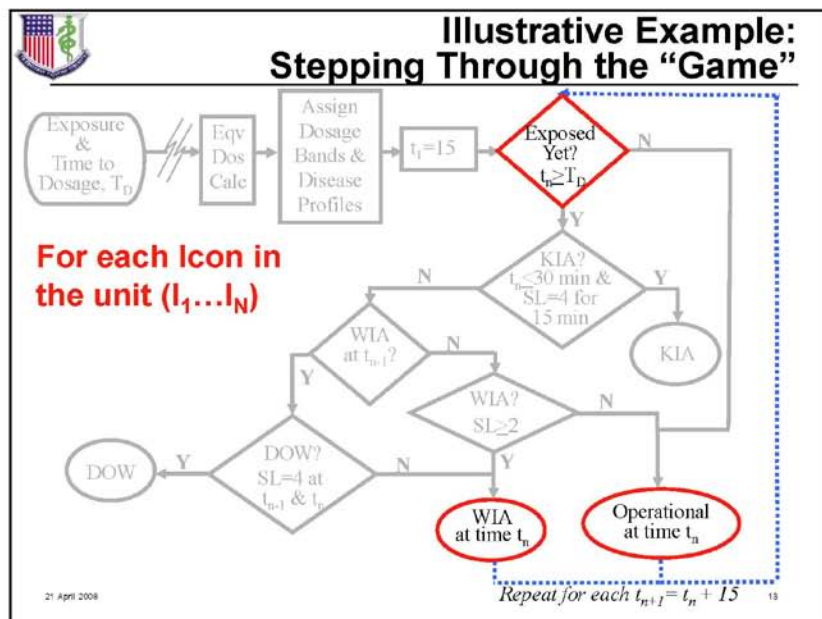
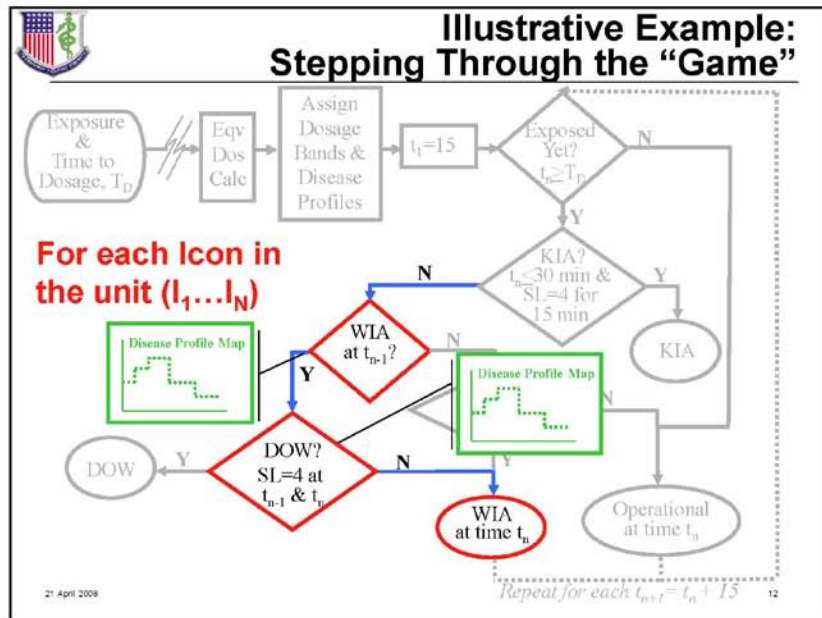
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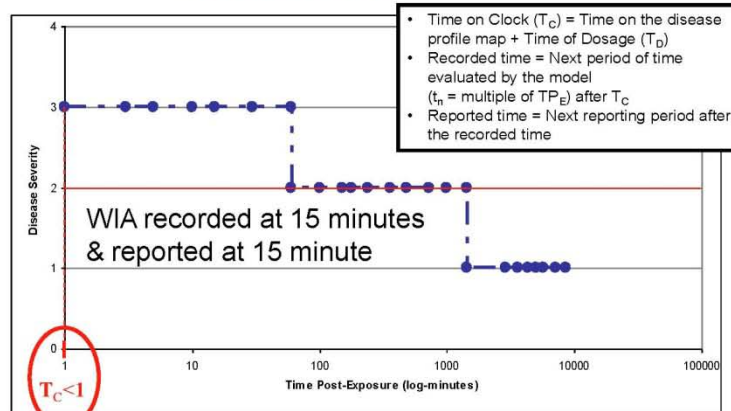






Illustrative Example: Icon₁ (I₁) Personnel Status

Disease Profile Map



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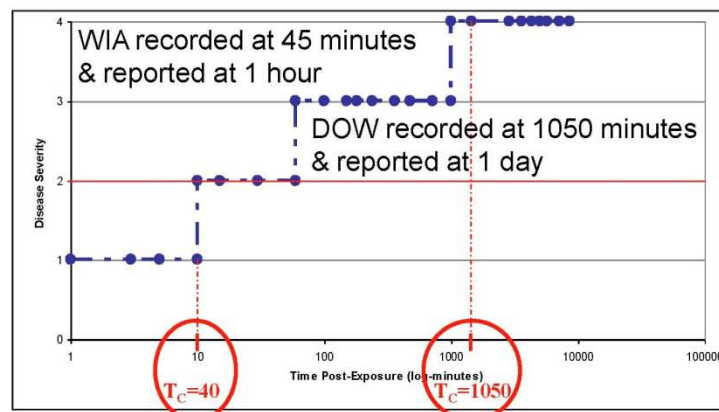
Time of Dosage < 1 min

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Illustrative Example: Icon₂ (I₂) Personnel Status

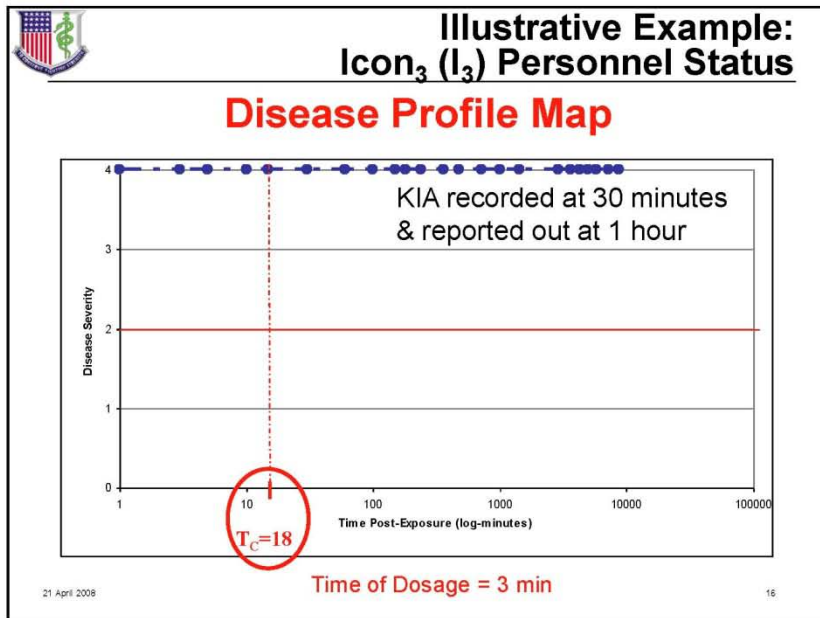
Disease Profile Map




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Time of Dosage = 30 min

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 **Illustrative Example: Results**

During the course of the “game” the model saved the following data:

- KIA at the recorded time
- WIA at the recorded time
- DOW at the recorded time

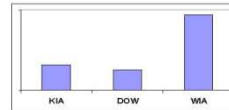
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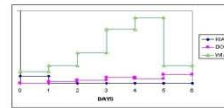
Illustrative Example: Results

Examples of Output Presentations:

- Personnel Status Totals:



- Personnel Status Differentials:



These graphs are notional only; they are not representative of any particular chemical agent

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Subject Matter Expert Meeting – Chemical Human Response Models

Questions?



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D. Nerve Agent Toxicity and Correlation of Dose – *Briefing*




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Medical Planning Guide for CBRN Casualty Estimation
Subject Matter Expert Meeting – Chemical Human Response Models

***AMedP-8(C) NATO Planning Guide for the
Estimation of CBRN Casualties***

**Nerve Agent Toxicity and
Correlation of Dose**

Deena Disraelly
Carl Curling
Robert Zirkle
Institute for Defense Analyses
21 April 2008



Briefing Purpose

- For GB and VX:
 - Propose toxicity values
 - Discuss the derivation of dosage ranges based on previous and proposed values
 - Present new dosage ranges
 - Discuss the equivalent dosage calculation

A similar discussion will be conducted for HD later

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Proposed Toxicity Values

		GB		VX	
		Median Toxicity (mg-min/m ³ or mg)	Probit Slope	Median Toxicity (mg-min/m ³ or mg)	Probit Slope
Vapor	Ocular	0.4	10	0.1	4
	Inhalation Severe	25	12	10	6
	Inhalation Lethal	35	12	15	6
	Percutaneous Severe	8000	5	25	6
	Percutaneous Lethal	12,000	5	150	6
Liquid	Percutaneous Severe	1000	5	2	6
	Percutaneous Lethal	1700	5	5	6

Multiservice Publication, FM 3-11.9/MCWP 3-37.1B/NTRP
3-11.32/AFTTP(I) 3-2.55, Potential Military Chemical/Biological
Agents and Compounds. January 2005

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Proposed Toxicity Values – GB

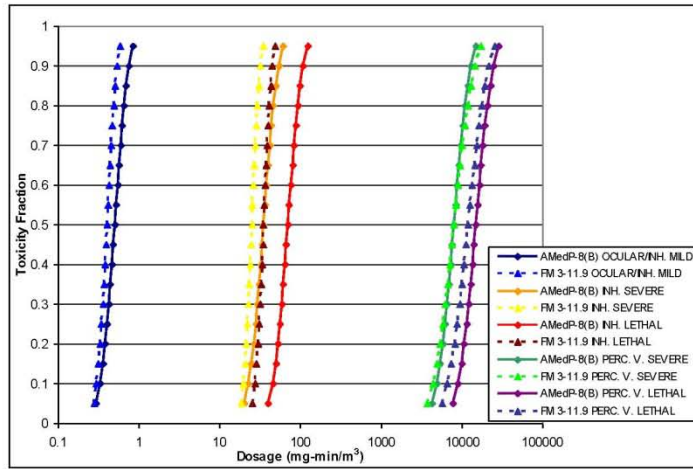
		Proposed (from FM 3-11.9)		AMedP-8(B)	
		Median Toxicity (mg-min/m ³ or mg/man)	Probit Slope	Median Toxicity (mg-min/m ³ or mg/man)	Probit Slope
Vapor	Ocular/Inh. Mild	0.4	10	0.5	7
	Inh. Severe	25	12	35	7
	Inh. Lethal	35	12	70	7
	Perc. Severe	8000	5	8000	6
	Perc. Lethal	12000	5	15000	6
Liquid	Perc. Severe	1000	5	1000	5
	Perc. Lethal	1700	5	1700	5

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Toxicity Values – GB

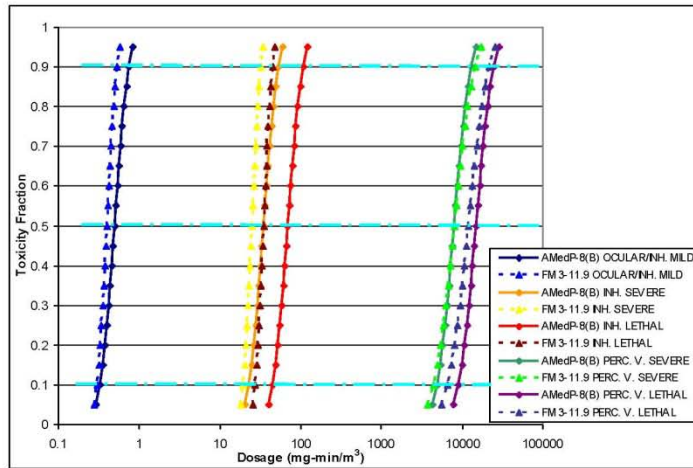


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Toxicity Values – GB



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Deriving Dosage Ranges – GB

	AMedP-8(B)	FM 3-11.9	
Begin Dosage Range 1	0	0	
End Dosage Range 1 -- Begin Dosage Range 2		0.2	
1% Ocular Injury (ocular/mild)		0.23	
10% Ocular Injury (ocular/mild)	0.33	0.30	
50% Ocular Injury (ocular/mild)	0.5	0.40	
90% Ocular Injury (ocular/mild)	0.75	0.54	
End Dosage Range 2 -- Begin Dosage Range 3	1	1	≈ EC ₀₁ ocular
End Dosage Range 3 -- Begin Dosage Range 4	6.5	6.5	
End Dosage Range 4 -- Begin Dosage Range 5	14	12	< EC ₀₁ severe
10% Severe Effects	23	19.55	
50% Severe Effects	35	27.37	
End Dosage Range 5 -- Begin Dosage Range 6	35	25	= EC ₅₀ severe
10% Lethal Effects	45	27.37	
End Dosage Range 6 -- Begin Dosage Range 7	50	30	≈ EC ₈₅ severe & LC ₁₅
90% Severe Effects	54	31.97	
50% Lethal Effects	70	35.00	
90% Lethal Effects	107	44.76	

All values are dosages expressed in mg-min/m³

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GB Equivalent Dosage Range

GB Equivalent Dosage Range	Description
< 0.2 mg-min/m ³	No observable effect
0.2 – 1 mg-min/m ³	10% – 90% Ocular disease, mild respiratory symptoms
1 – 6.5 mg-min/m ³	Rhinorrhea, dimmed vision, mild headache, excessive airway secretions induce cough; Maximal Ocular disease
6.5 – 12 mg-min/m ³	Runny nose, dim vision or eye pain with sensitivity to light, nausea, frequent cough
12 – 25 mg-min/m ³	Maximal secretions and eye effects: vomiting, abdominal cramps, severe headache with anxiety and confusion, tight chest, convulsions; 10% - 50% severe effects
25 – 30 mg-min/m ³	Twitching, weakness, diarrhea, convulsions progressing to collapse and respiratory failure; 10% lethal effects
> 30 mg-min/m ³	Collapse and respiratory failure; extremely severe effects that cause death in more than half; > 90% severe effects

Tables derived from DICE methodology; toxicity values updated to reflect current values

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Proposed Toxicity Values – VX

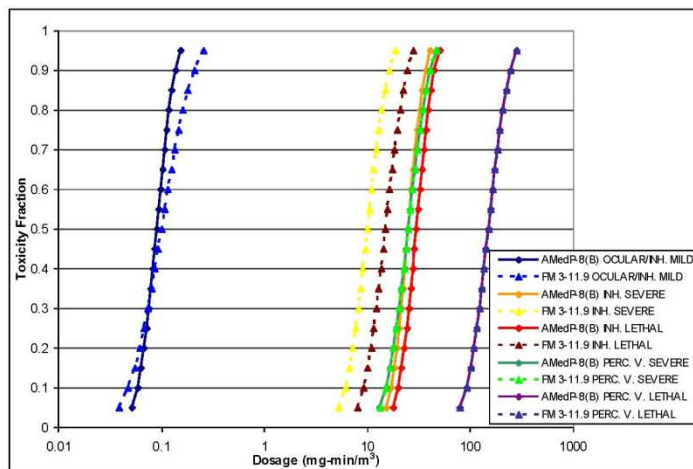
		Proposed (from FM 3-11.9)		AMedP-8(B)	
		Median Toxicity (mg-min/m ³ or mg/man)	Probit Slope	Median Toxicity (mg-min/m ³ or mg/man)	Probit Slope
Vapor	Ocular/Inh. Mild	0.1	4	0.1	7
	Inh. Severe	10	6	25	7.5
	Inh. Lethal	15	6	30	7
	Perc. Severe	25	6	25	6
	Perc. Lethal	150	6	150	6
Liquid	Perc. Severe	2	6	5	5
	Perc. Lethal	5	6	10	6

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Toxicity Values – VX

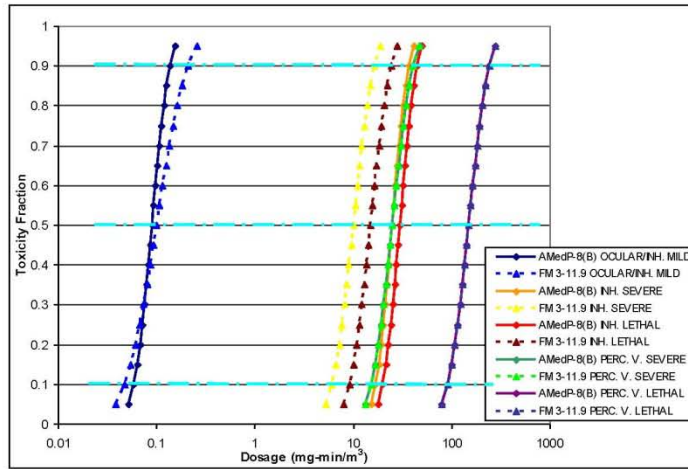


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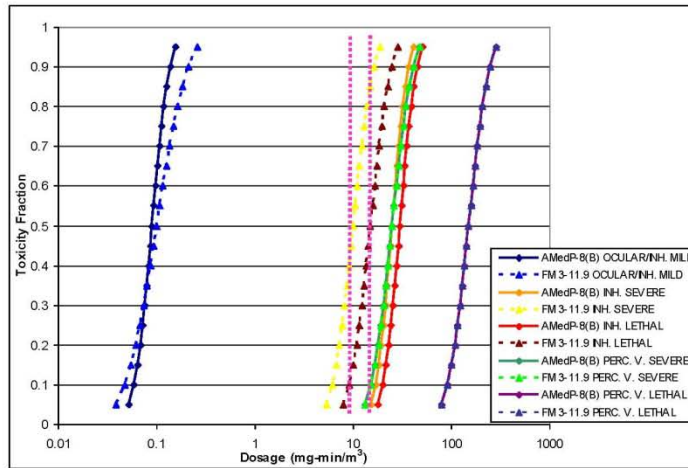
9



Toxicity Values – VX



Toxicity Values – VX





Deriving Dosage Ranges – VX

	AMedP-8(B)	FM 3-11.9	
Begin Dosage Range 1	0	0.00	
		0.02	
1% Ocular Injury (ocular/mild)		0.03	
10% Ocular Injury (ocular/mild)	0.06	0.05	
50% Ocular Injury (ocular/mild)	0.09	0.10	
90% Ocular Injury (ocular/mild)	0.14	0.21	
End Dosage Range 1 -- Begin Dosage Range 2	0.2	0.30	≈ EC _{t99} ocular
End Dosage Range 2 -- Begin Dosage Range 3		2	
End Dosage Range 3 -- Begin Dosage Range 4	12	4	< EC _{t91} severe
10% Severe Effects	17	6.12	
10% Lethal Effects	20	9.17	
50% Severe Effects	25	10.00	
End Dosage Range 4 -- Begin Dosage Range 5	25	10	= EC _{t50} severe
10% Lethal Effects			
End Dosage Range 5 -- Begin Dosage Range 6	30	13	≈ EC _{t95} severe & LC _{t15}
90% Severe Effects	37	16.35	
50% Lethal Effects	30	15.00	
90% Lethal Effects	45	24.53	

All values are dosages expressed in mg-min/m³

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VX Equivalent Dosage Range

VX Equivalent Dosage Range	Description
< 0.02 mg-min/m ³	No observable effect
0.02 – 0.3 mg-min/m ³	10% – 90% Ocular disease, mild respiratory symptoms
0.3 – 2 mg-min/m ³	Rhinorrhea, dimmed vision, mild headache, excessive airway secretions induce cough; Maximal Ocular disease
2 – 4 mg-min/m ³	Runny nose, dim vision or eye pain with sensitivity to light, nausea, frequent cough
4 – 10 mg-min/m ³	Maximal secretions and eye effects: vomiting, abdominal cramps, severe headache with anxiety and confusion, tight chest, convulsions; 10% - 50% severe effects
10 – 13 mg-min/m ³	Twitching, weakness, diarrhea, convulsions progressing to collapse and respiratory failure; 10% lethal effects
> 13 mg-min/m ³	Collapse and respiratory failure; extremely severe effects that cause death in more than half; > 90% severe effects

Tables derived from DICE methodology; toxicity values updated to reflect current values

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Calculating Equivalent Dosages – VX

- Equivalent Dosage Calculation for VX:

$$ED_{VX} = D_{\text{vapor}} + D_{\text{vapor}}F_c + D_{\text{liquid}}F_d$$

$$F_c = ECt_{50(VX/IH/V)} / ECt_{50(VX/PC/V)} = 10/25 = 0.4$$

$$F_d = ECt_{50(VX/IH/V)} / ED_{50(VX/PC/L)} = 10/2 = 5$$

VX/IH/V = VX/Inhalation/Vapor

VX/PC/V = VX/Percutaneous/Vapor

VX/PC/L = VX/Percutaneous/Liquid

- Propose to include VX liquid exposure as shown
 - Recognize that casualties may be estimated earlier (and possibly at slightly higher severity) than anticipated following actual exposure to VX

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Allied Medical Publication 8 (AMedP-8) SD.3 2008
Medical Planning Guide for CBRN Casualty Estimation
Subject Matter Expert Meeting – Chemical Human Response Models

Questions?



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E. Nerve Agent Response: Signs and Symptoms Over Time as a Function of Dose – Briefing




Allied Medical Publication 8 (AMedP-8) SD.3 2008
Medical Planning Guide for CBRN Casualty Estimation
Subject Matter Expert Meeting – Chemical Human Response Models

***AMedP-8(C) NATO Planning Guide for the
Estimation of CBRN Casualties***

**Nerve Agent Response:
Signs and Symptoms Over Time
as a Function of Dose**

Bob Zirkle
Carl Curling
Deena Disraelly
Institute for Defense Analyses
22 April 2008



Briefing Outline

- Describe GB & VX model assumptions.
- Describe exposure/dosage ranges and their clinically observable effects for GB & VX.
- Describe the five severity levels and their associated nerve agent effects for each of six physiological systems (upper GI, lower GI, respiratory, ocular, muscular, cognitive).
- Present disease progression maps displaying the severity levels across time for each system at each exposure/dosage range for GB and VX.

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MODEL ASSUMPTIONS

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Overarching Model Assumptions

- Human response can be modeled over time as a function of dose-related effects (signs and symptoms).
 - Dose-related effects apply for all doses in a specified dose range.
- Human response to an exposure can be represented by the median individual in each dose/dosage/exposure band.
- Toxic Load Exponent = 1; Haber's Law applies.
 - Human response to cumulative dosages/doses (regardless of exposure length in the exposure models) is the function of 2-min exposures.
 - Individual disease profiles begin after completion of exposure, as expressed in the exposure model.
- Prior to exposure, individuals are in perfect health.
- 70 kilogram man, breathing 15 liters per minute.

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GB/VX Model Assumptions

- Percutaneous exposure route is neglected for GB attack
 - No percutaneous vapor due to negligible contribution relative to inhaled vapor
 - No percutaneous liquid due to the agent's high volatility.
- Inhalation and percutaneous exposure routes are included for VX attack
 - Dosages and doses resulting from exposure to inhaled VX vapor, percutaneous VX vapor, and percutaneous liquid VX can be equated to a single equivalent dosage through a ratio method.
 - Equivalent dosage is the equivalent vapor dosage that would result in a disease progression (S/S over time) similar to the actual combination of dosages and doses to which the individual was exposed.
 - The disease progressions resulting from inhaled vapor, percutaneous vapor, and percutaneous liquid are all similar and follow the equivalent vapor dosage: may over-estimate severity levels and shift timelines.

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GB & VX EQUIVALENT DOSAGE BANDS

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GB Equivalent Dosage Range

GB Equivalent Dosage Range	Description
< 0.2 mg-min/m ³	No observable effect
0.2 – 1 mg-min/m ³	10% – 90% Ocular disease, rhinorrhea
1 – 6.5 mg-min/m ³	Rhinorrhea, dimmed vision, mild headache, excessive airway secretions induce cough; Maximal Ocular disease
6.5 – 12 mg-min/m ³	Runny nose, dim vision or eye pain with sensitivity to light, nausea, frequent cough
12 – 25 mg-min/m ³	Maximal secretions and eye effects: vomiting, abdominal cramps, severe headache with anxiety and confusion, tight chest, convulsions; 10% - 50% severe effects
25 – 30 mg-min/m ³	Twitching, weakness, diarrhea, convulsions progressing to collapse and respiratory failure; 10% lethal effects
> 30 mg-min/m ³	Collapse and respiratory failure; extremely severe effects that cause death in more than half; > 90% severe effects

Tables derived from DICE methodology; toxicity values updated to reflect current values

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VX Equivalent Dosage Range

VX Equivalent Dosage Range	Description
< 0.02 mg-min/m ³	No observable effect
0.02 – 0.3 mg-min/m ³	10% – 90% Ocular disease, rhinorrhea
0.3 – 2 mg-min/m ³	Rhinorrhea, dimmed vision, mild headache, excessive airway secretions induce cough; Maximal Ocular disease
2 – 4 mg-min/m ³	Runny nose, dim vision or eye pain with sensitivity to light, nausea, frequent cough
4 – 10 mg-min/m ³	Maximal secretions and eye effects: vomiting, abdominal cramps, severe headache with anxiety and confusion, tight chest, convulsions; 10% - 50% severe effects
10 – 13 mg-min/m ³	Twitching, weakness, diarrhea, convulsions progressing to collapse and respiratory failure; 10% lethal effects
> 13 mg-min/m ³	Collapse and respiratory failure; extremely severe effects that cause death in more than half; > 90% severe effects

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GB/VX SIGNS & SYMPTOMS SEVERITY LEVELS & MAPS

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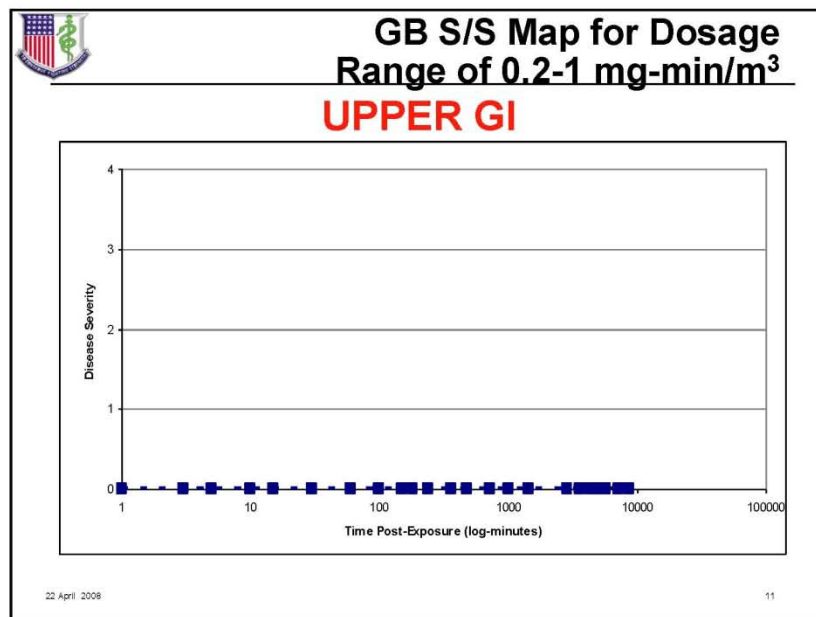
Severity Definitions		
Degrees	Description	
0	N.O.E.	No observable effect
1	Mild	Disease or wounds manifesting signs and symptoms of such severity that individuals can care for themselves or be helped by untrained personnel and their ability to conduct the assigned mission may or may not be impacted by the manifested signs and symptoms.
2	Moderate	Disease or wounds manifesting signs and symptoms of such severity that medical care may be required; general condition permits treatment as outpatient and some continuing care and relief of pain may be required before definitive care is given; condition may be expected to interrupt or preclude ability to conduct the assigned mission.
3	Severe	Disease or wounds manifesting signs and symptoms of such severity that there is cause for immediate concern but there is no imminent danger to life; individual is acutely ill and likely requires hospital care. Indicators are questionable – condition may or may not reverse without medical intervention; individual is unable to conduct the assigned mission due to severity of signs and symptoms.
4	Very Severe	Disease or wounds manifesting signs and symptoms of such severity that life is imminently endangered. Indicators are unfavorable – condition may or may not reverse even with medical intervention; prognosis is lethality without medical intervention; individual is unable to conduct the assigned mission and is unexpected to return to the mission due to severity of signs and symptoms.

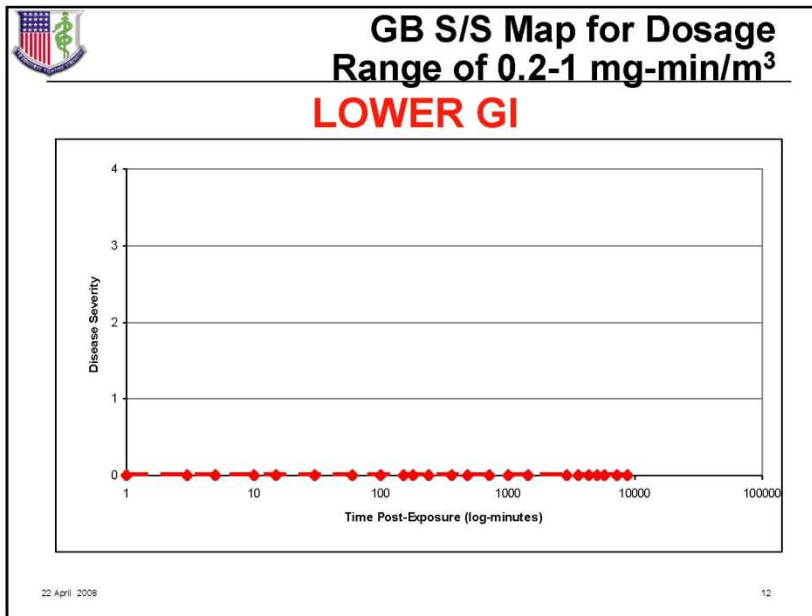



GB/VX S/S Severities

Signs / Symptoms Severity	Upper GI Signs/Symptoms	Lower GI Signs/Symptoms
0	No observable effect	No observable effect
1	Upset stomach and nausea; watering mouth and frequent swallowing to avoid vomiting	Abdominal pain or cramps; occasional diarrhea and uncomfortable urge to defecate
2	Episodes of vomiting, possibly including dry heaves; severe nausea and possibility of continued vomiting	Frequent diarrhea and cramps; continuing defecation
3		Uncontrollable diarrhea and urination; painful cramps
4		

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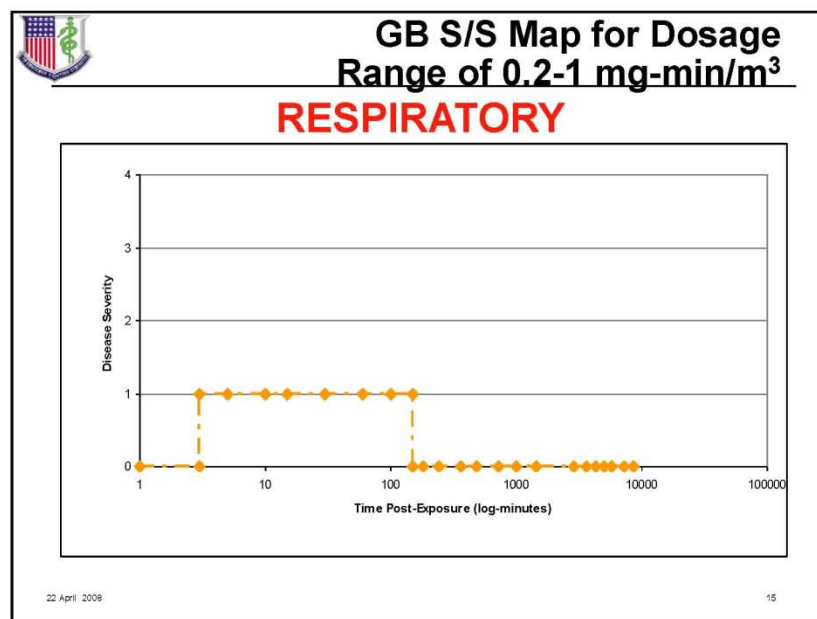
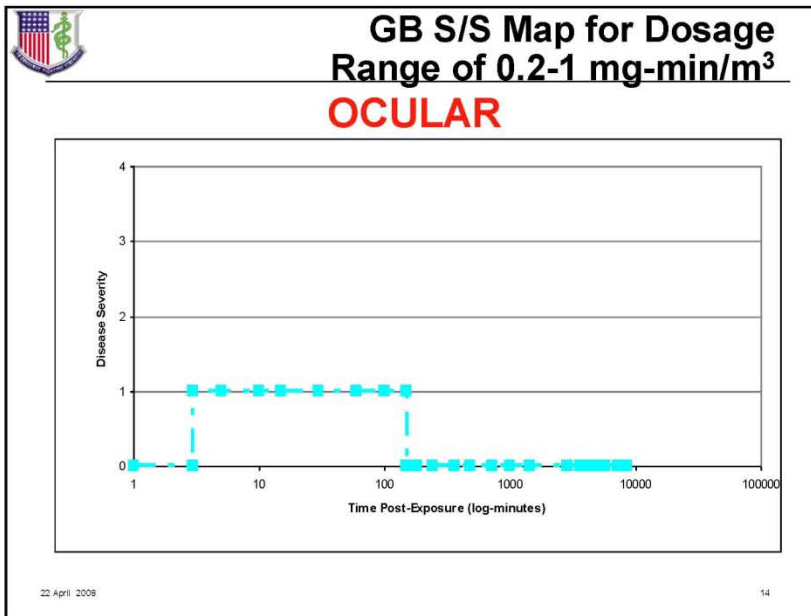





 **GB/VX S/S Severities**

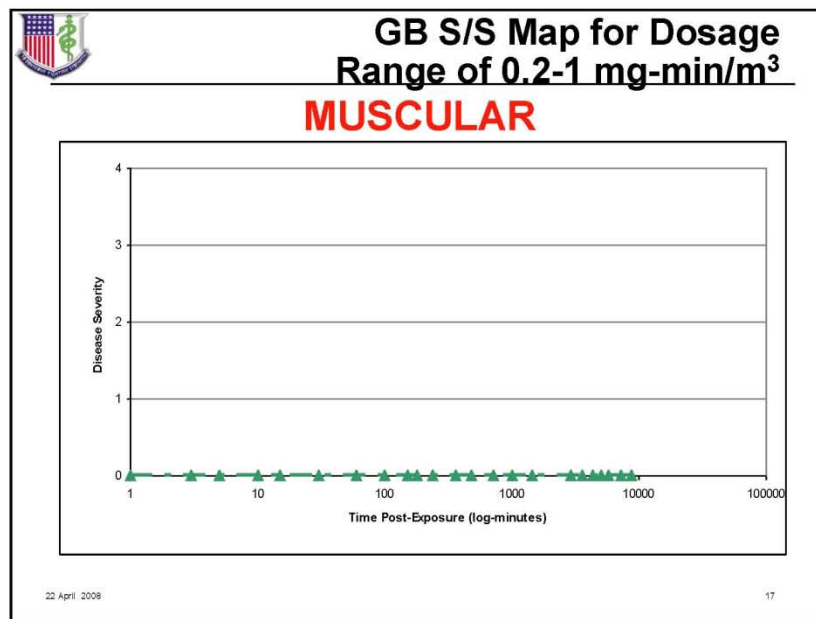
Signs / Symptoms Severity	Ocular Signs/Symptoms	Respiratory Signs/Symptoms
0	No observable effect	No observable effect
1	Slightly blurred, dim (may be due to tearing), or possibly irritated (conjunctival erythema and/or edema) vision	Mild shortness of breath; tight chest, coughing, and runny nose (rhinorrhea)
2	Blurred vision due to dimming or difficulty opening eyes; eyes sensitive to light or puffy; potential for pressure behind the eyes, eye pain, or heavy tearing	Frank shortness of breath; difficult to breathe, wheezing breath, respiratory congestion, bronchorrhea
3	Functional blindness (possibly accompanied by extreme headache)	Breathing sporadically stops and starts, skin has a purple or blue color, hemoptysis
4		Breathing stops completely or struggling to breath; prostration

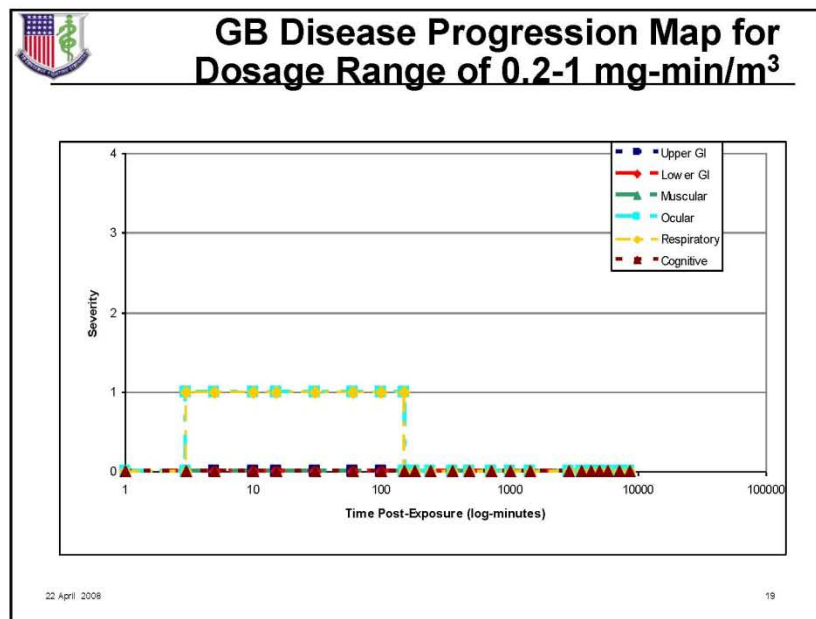
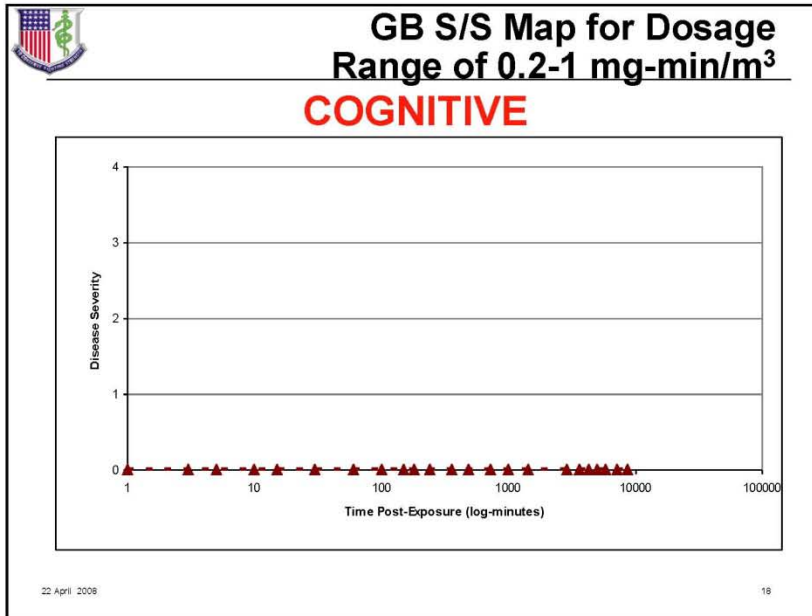
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 GB/VX S/S Severities		
Signs / Symptoms Severity	Muscular Signs/Symptoms	Cognitive Signs/Symptoms
0	No observable effect	No observable effect
1	Muscle twitching/fasciculation; tired and weak feelings	Feelings of anxiety, irritability or euphoria
2	Muscle trembling; lack of coordination; increased feelings of tiredness and weakness	Difficulty in concentration
3	Severe generalized trembling with or without convulsions	Aphasia; memory loss; disorientation
4	Paralysis	Unconsciousness

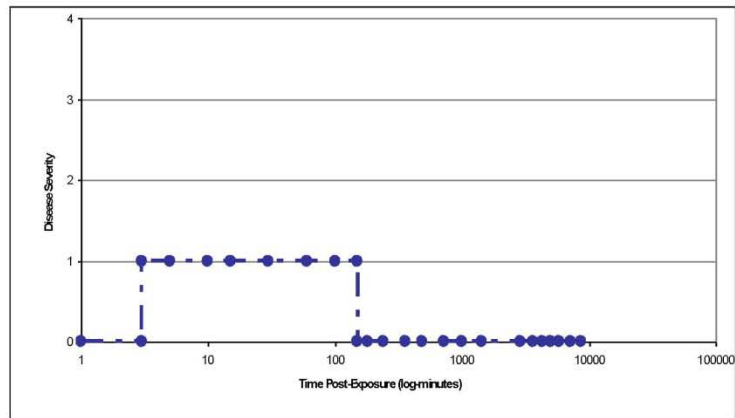
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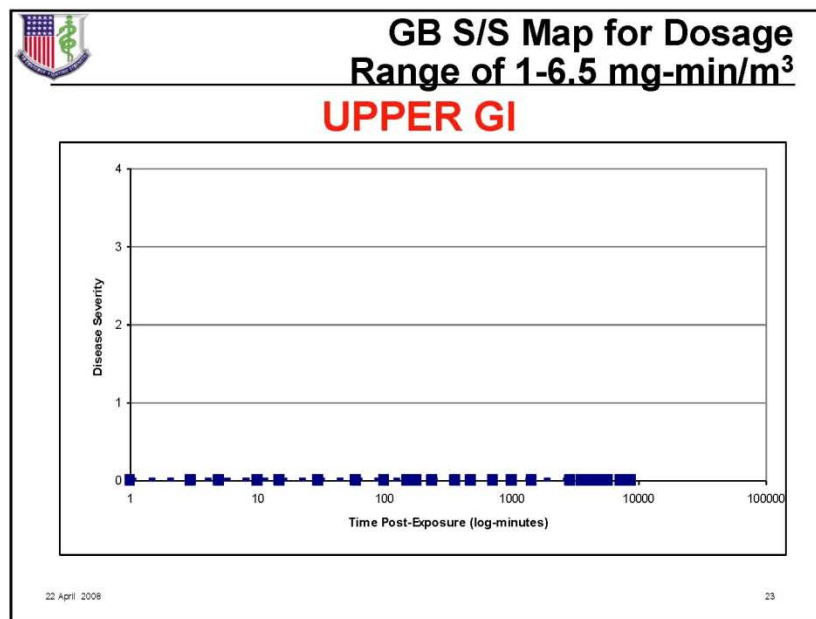
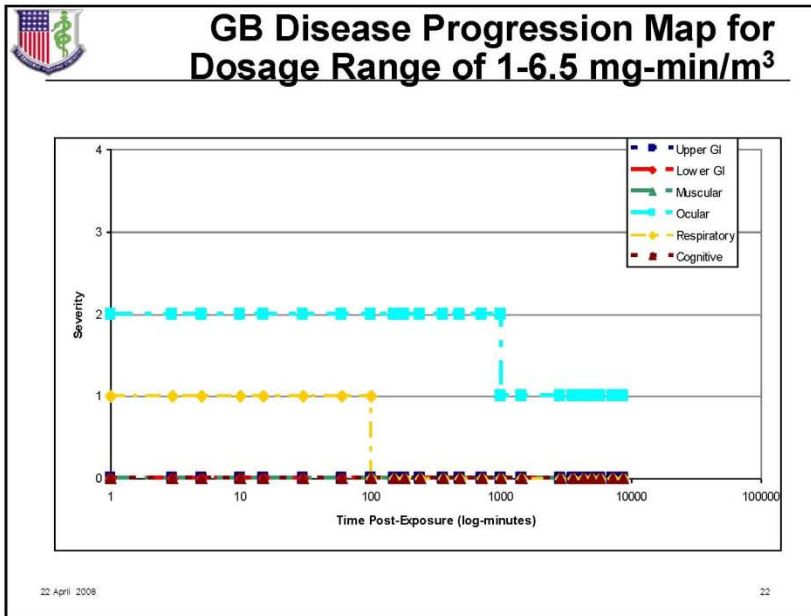


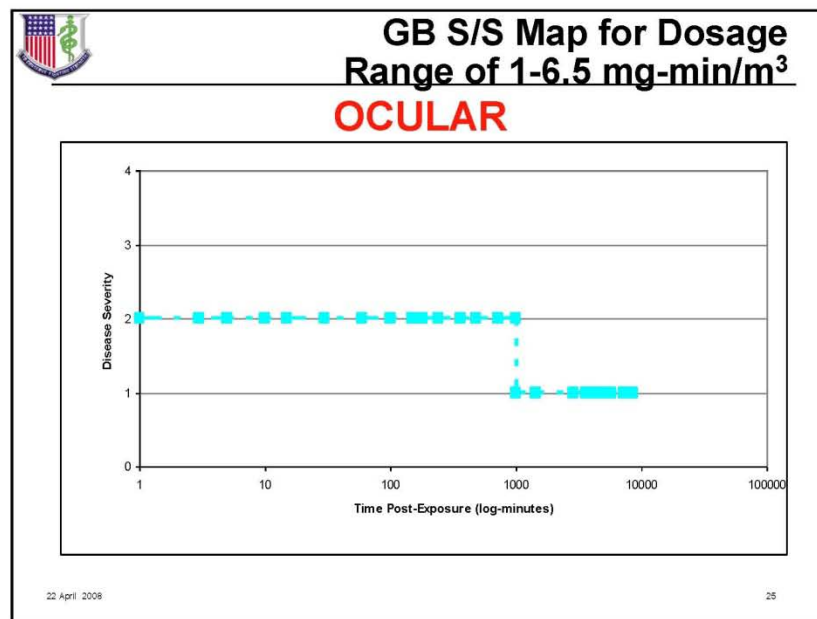
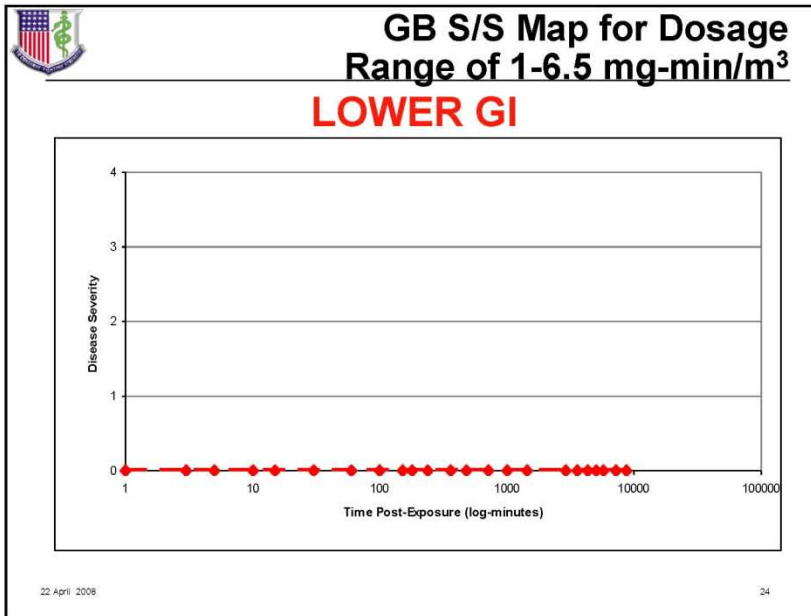


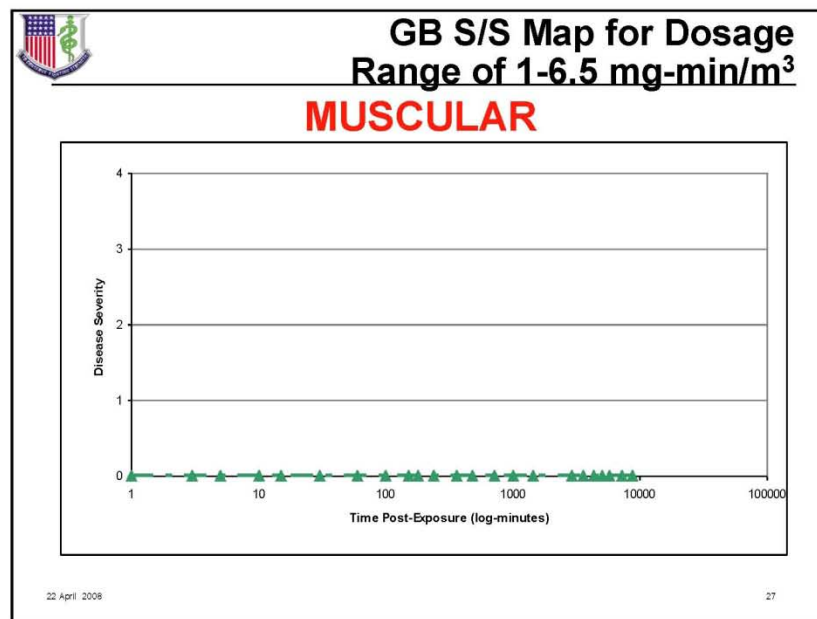
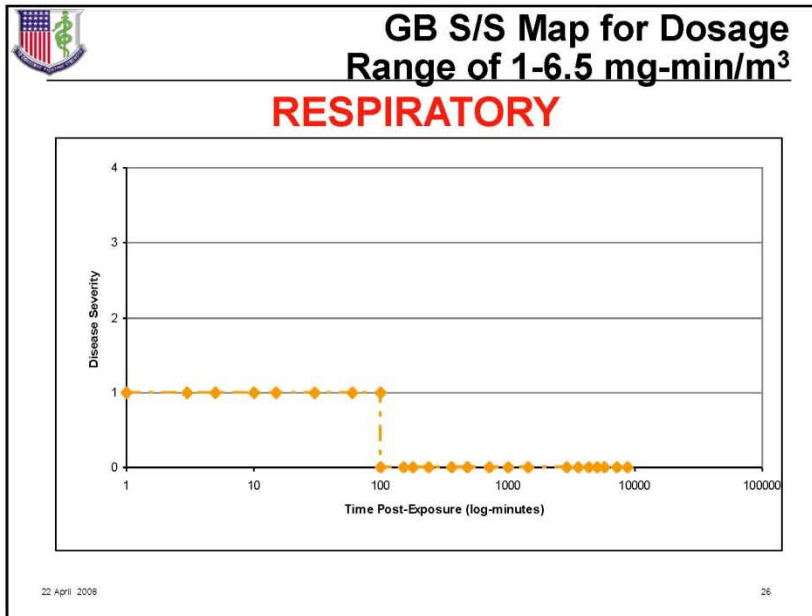


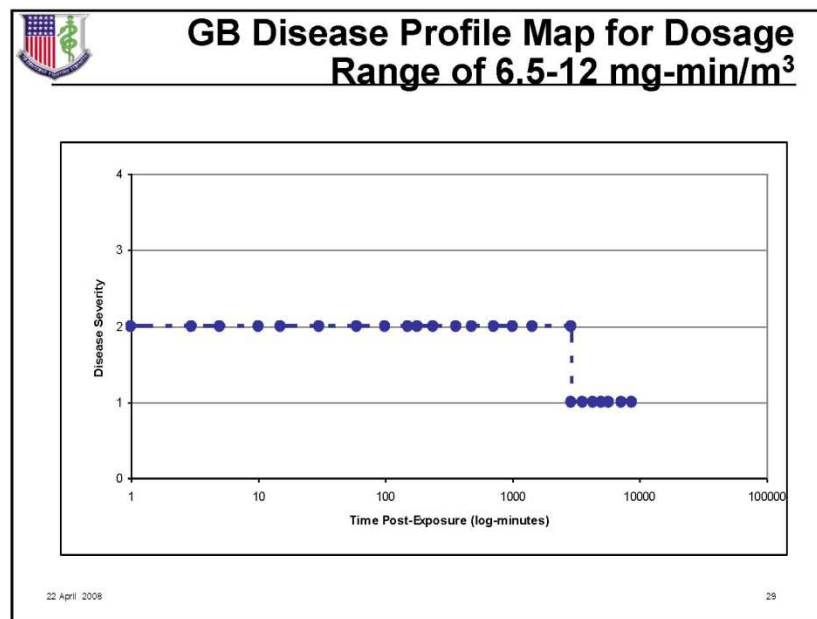
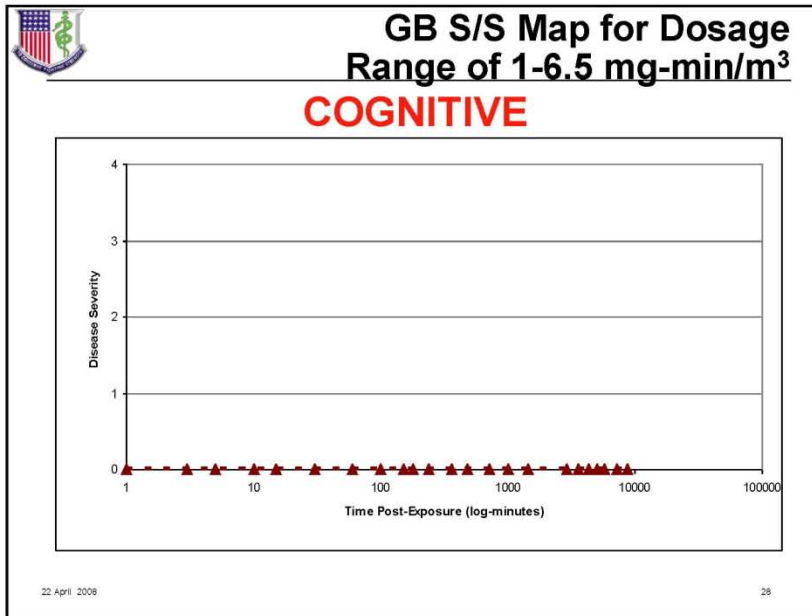
GB Disease Profile Map for Dosage Range of 0.2-1 mg-min/m³

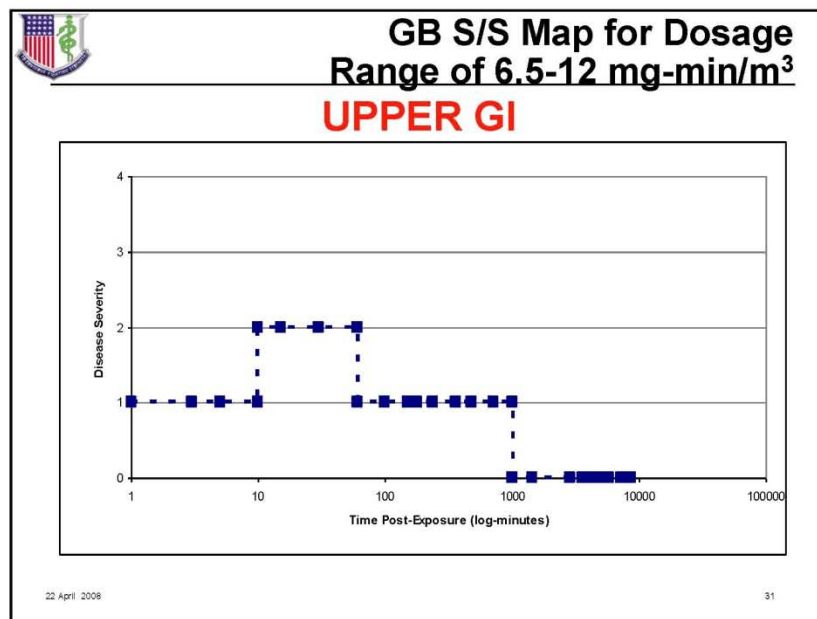
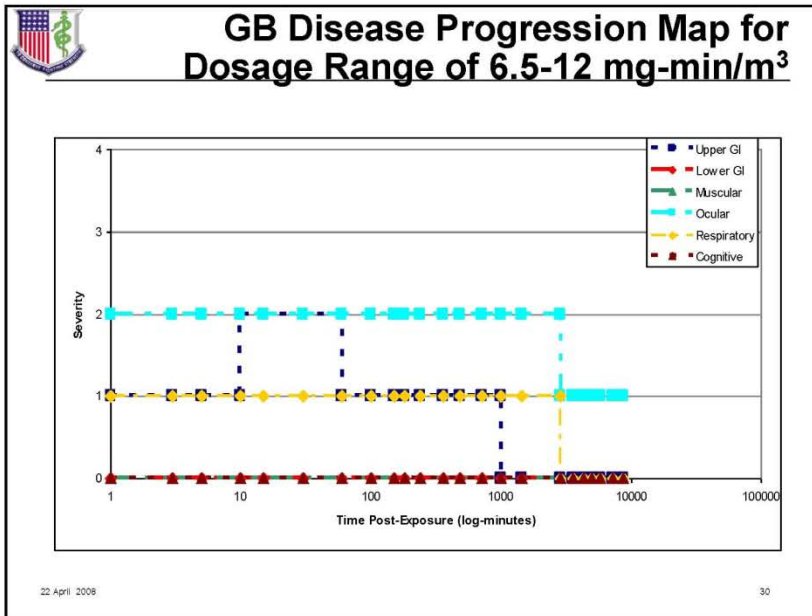


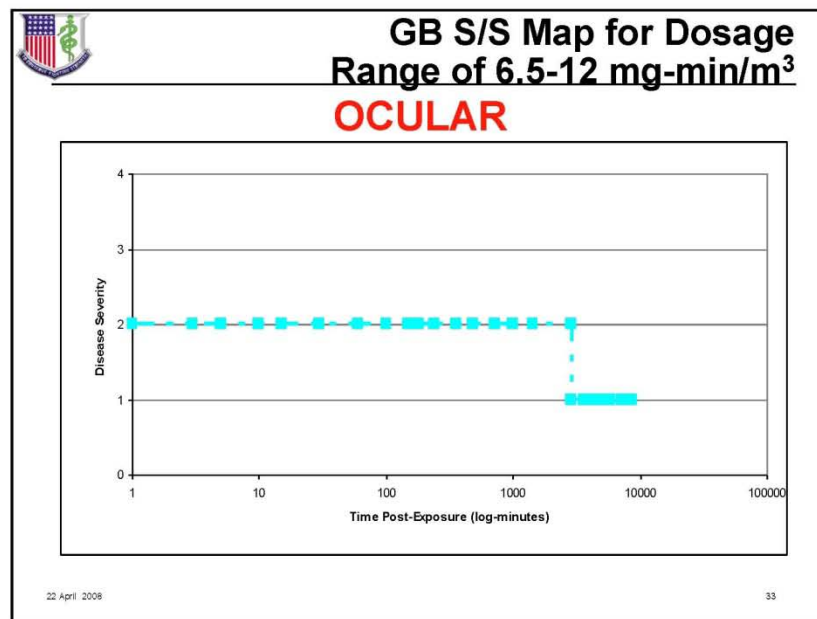
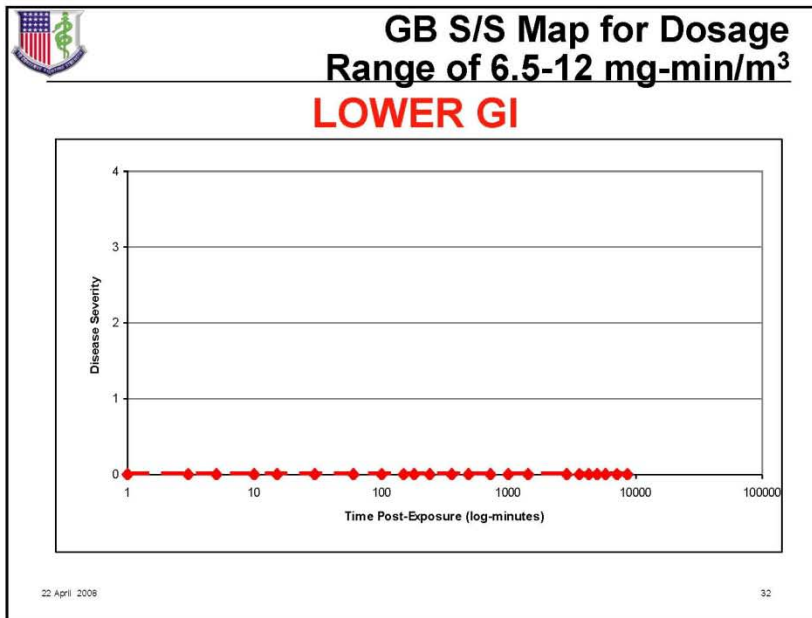


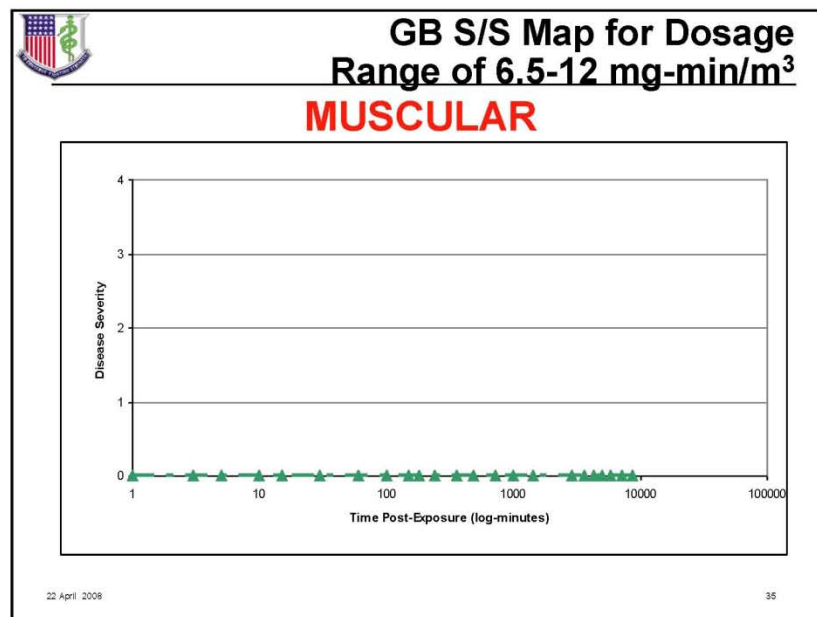
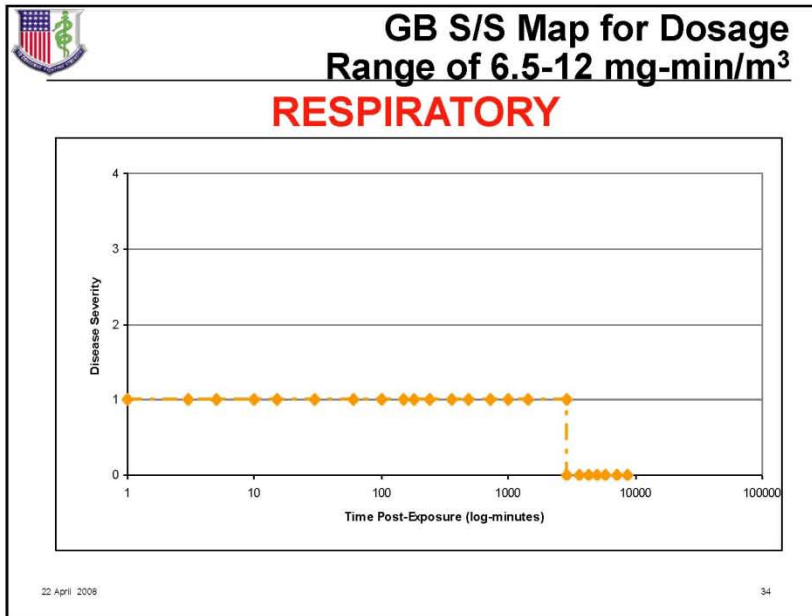


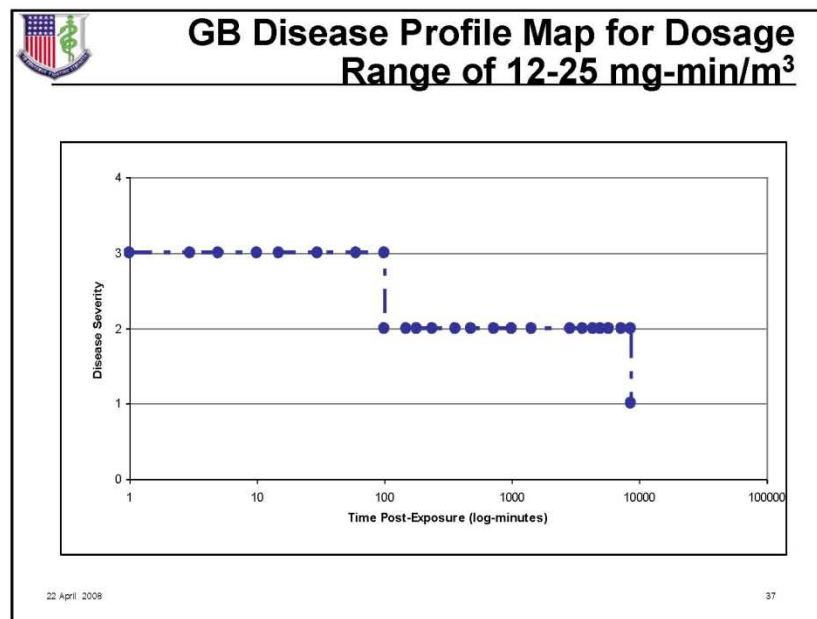
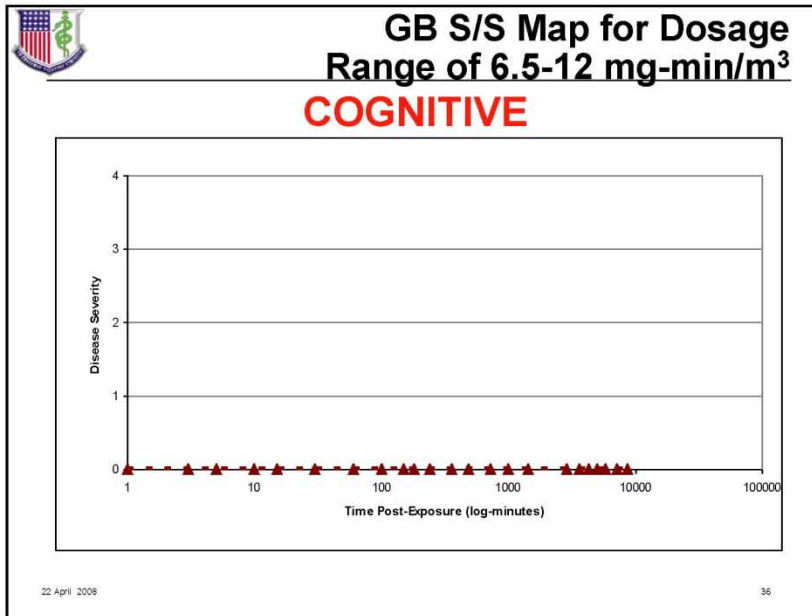


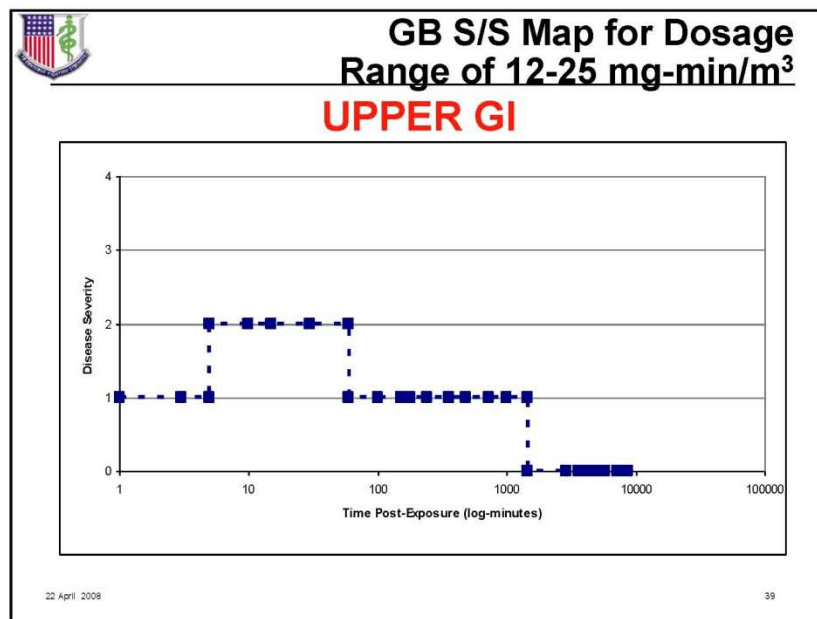
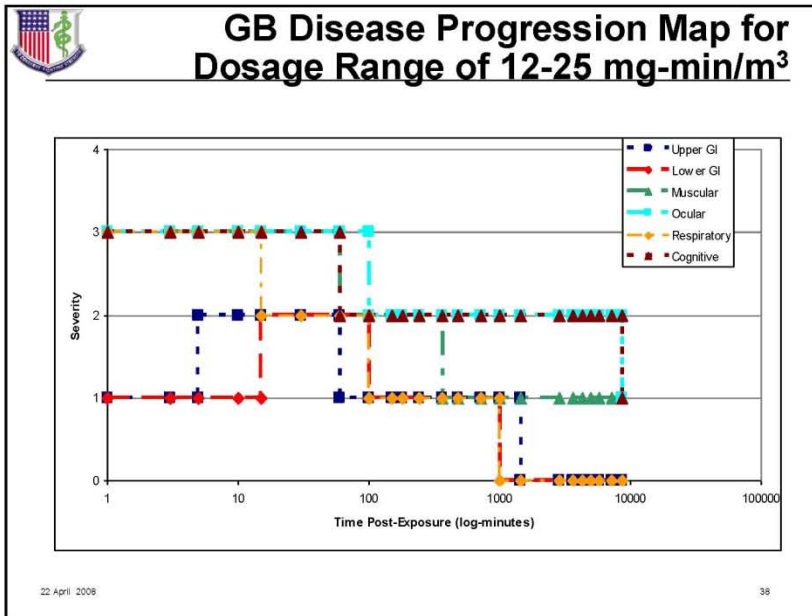


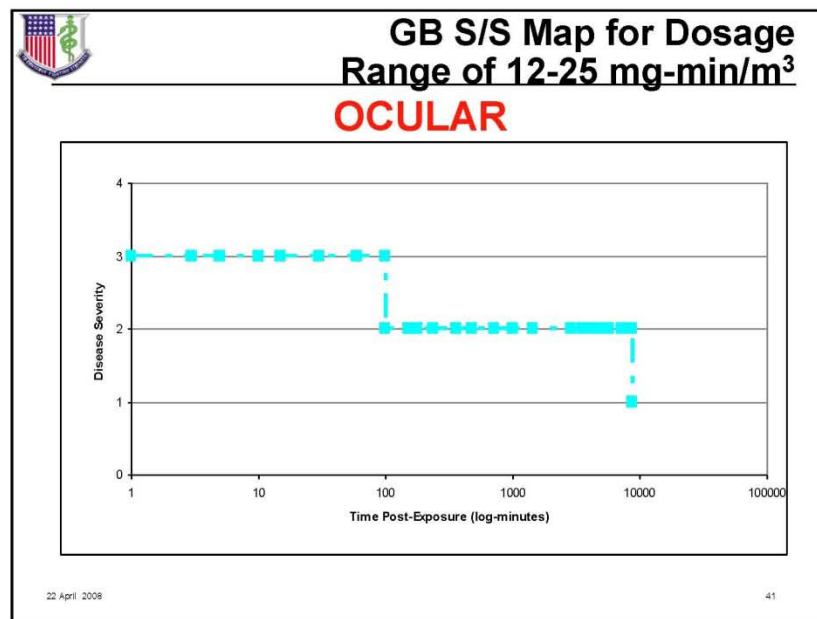
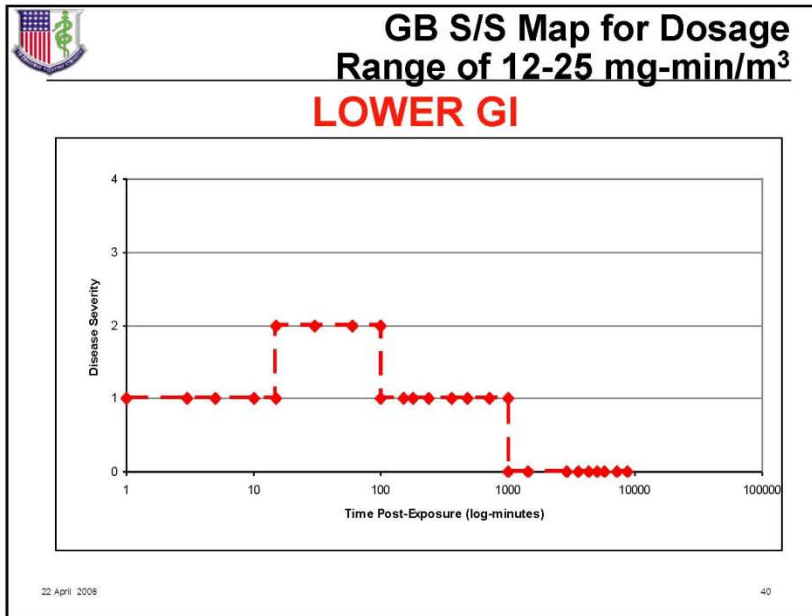


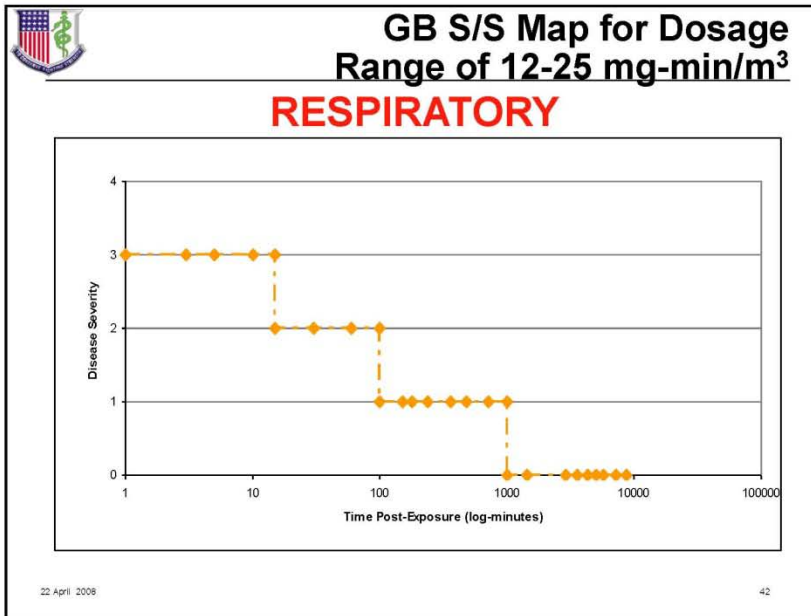


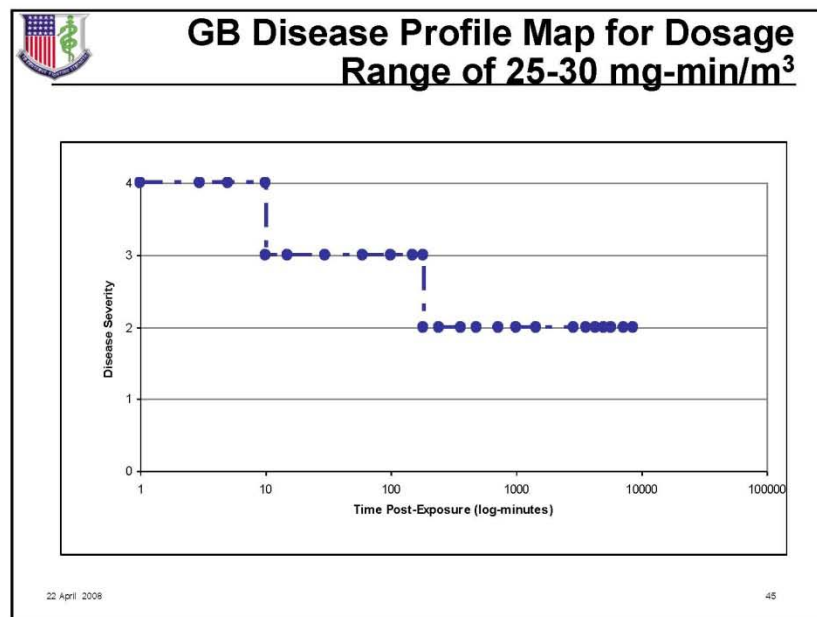
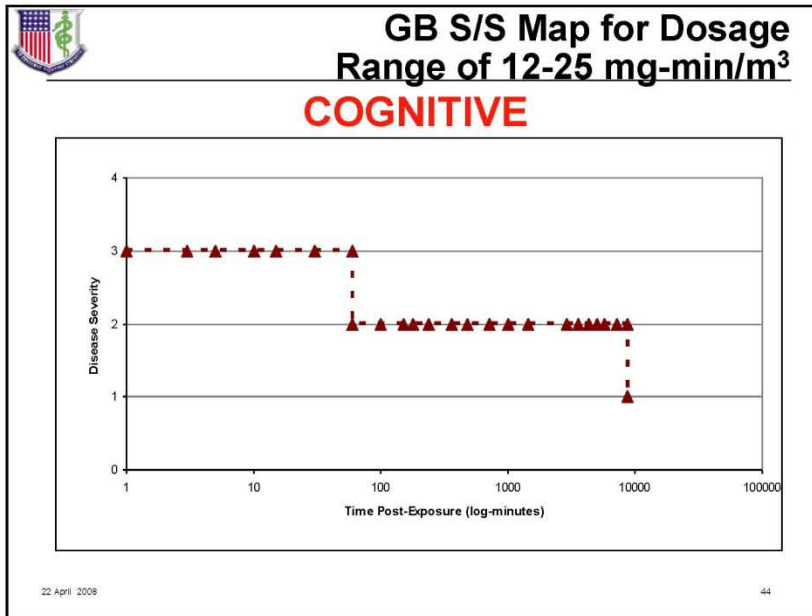


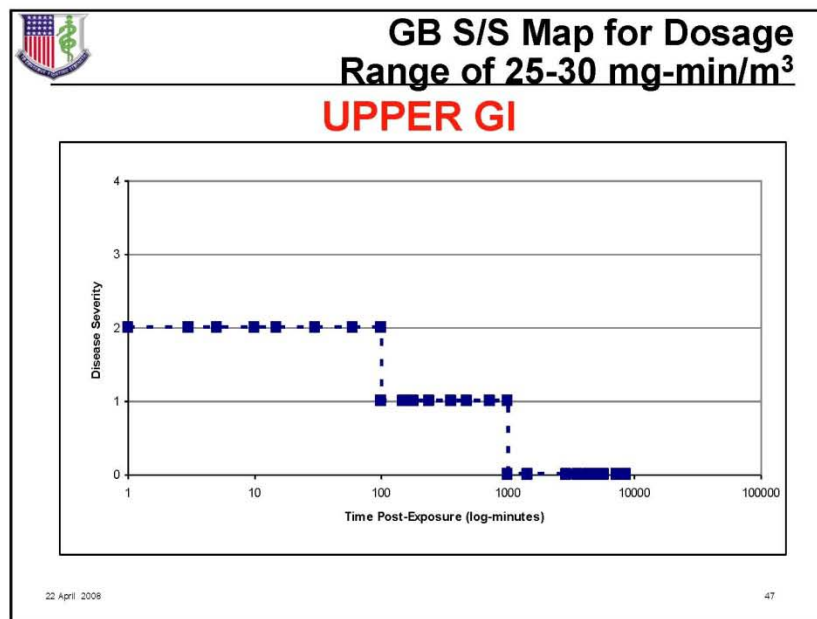
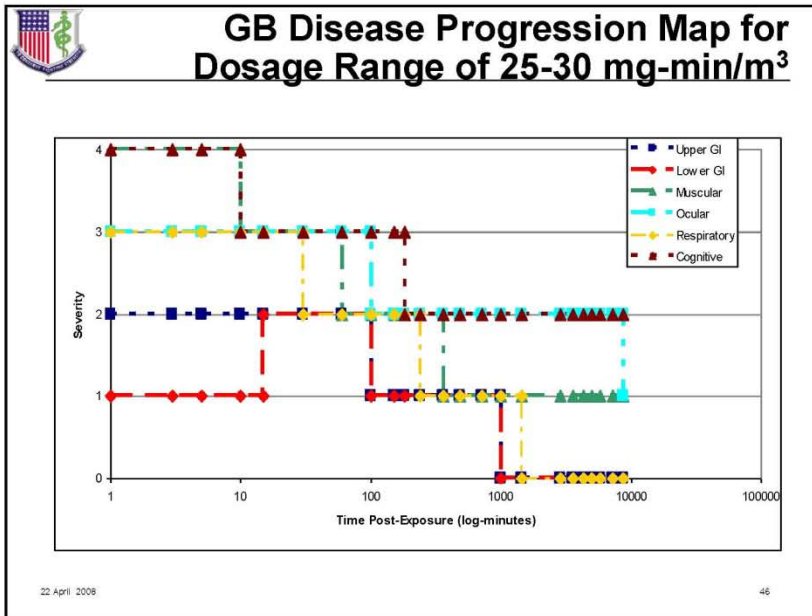


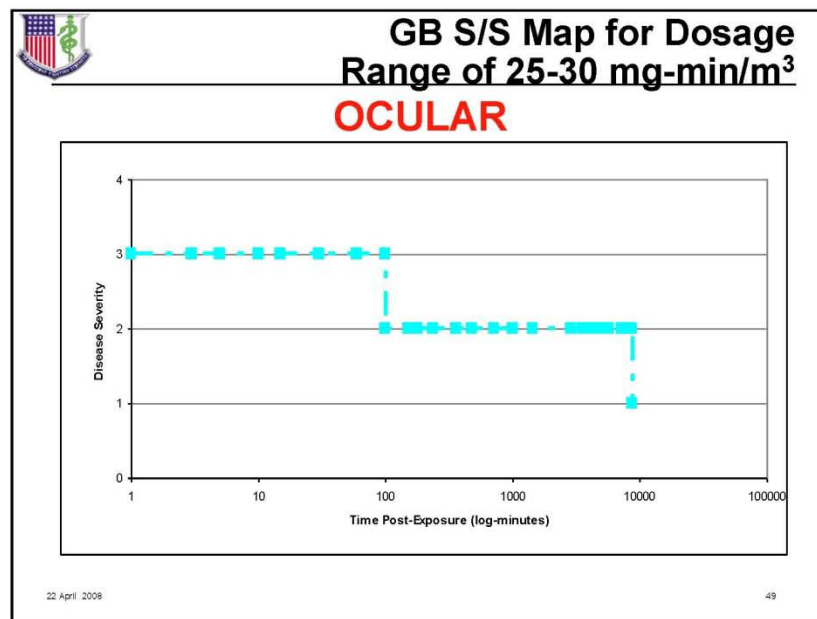
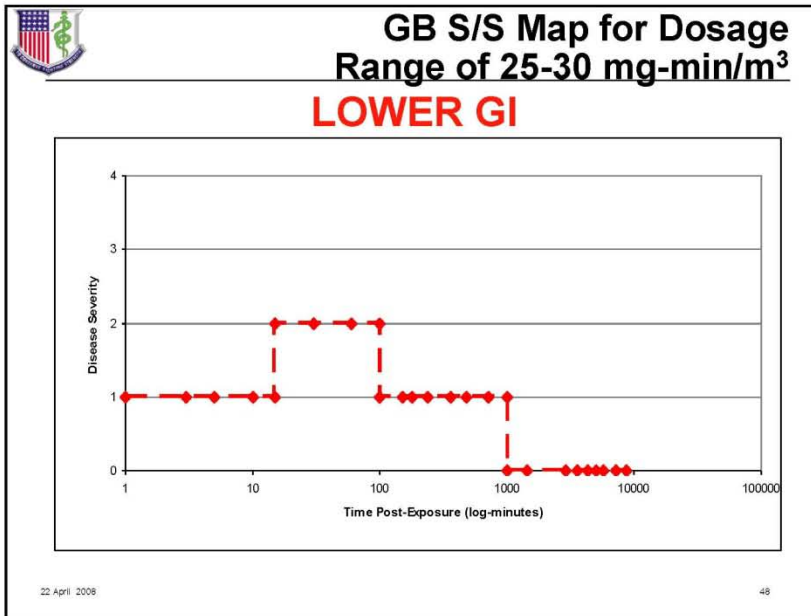


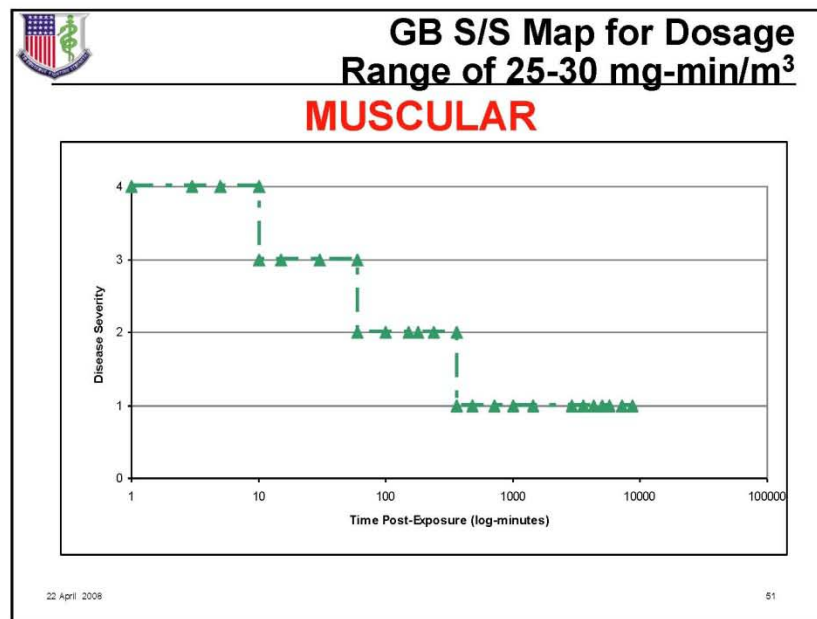
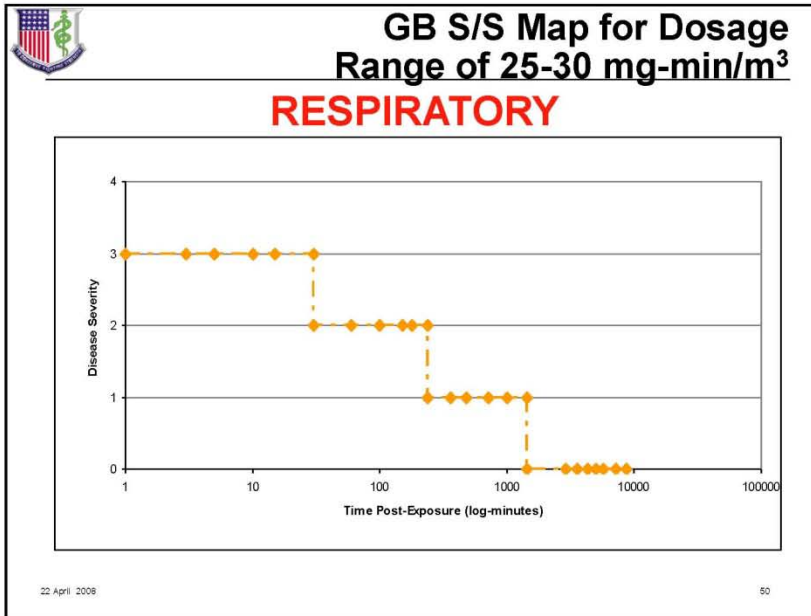


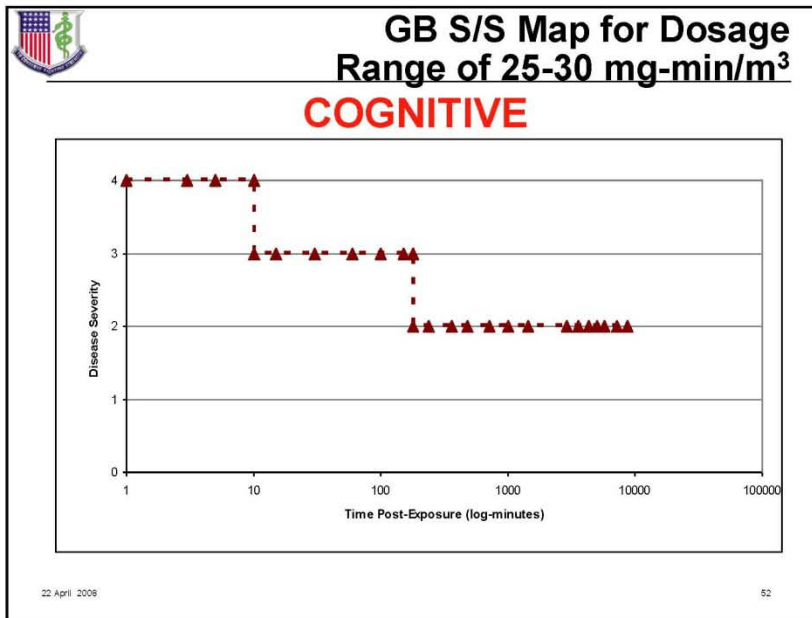


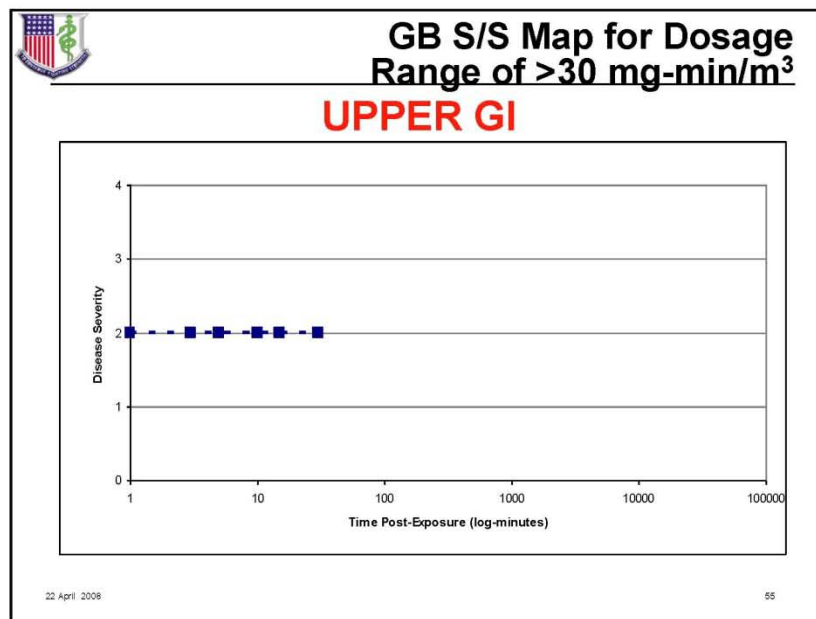
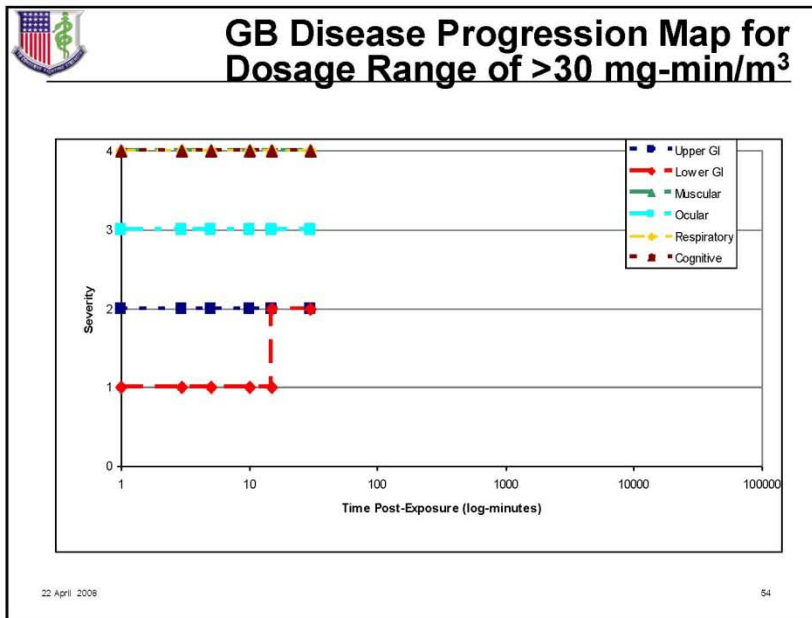


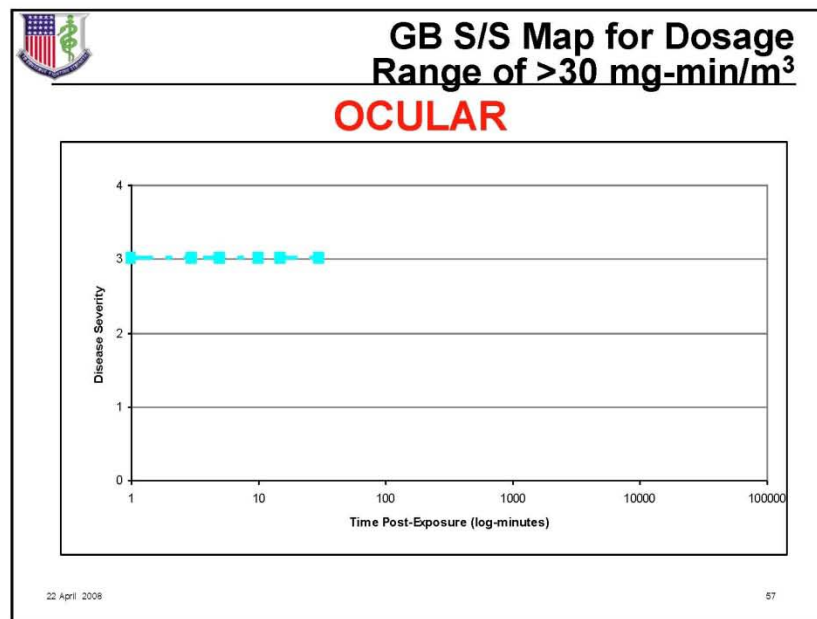
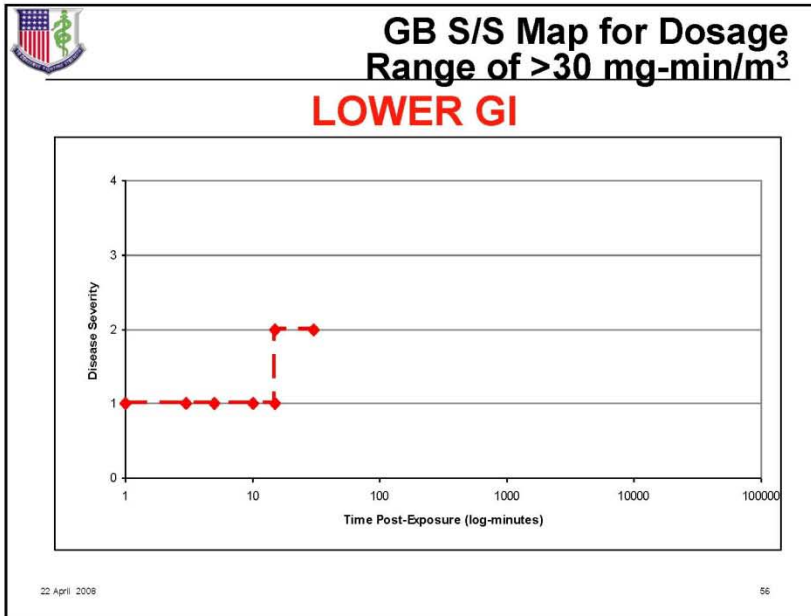


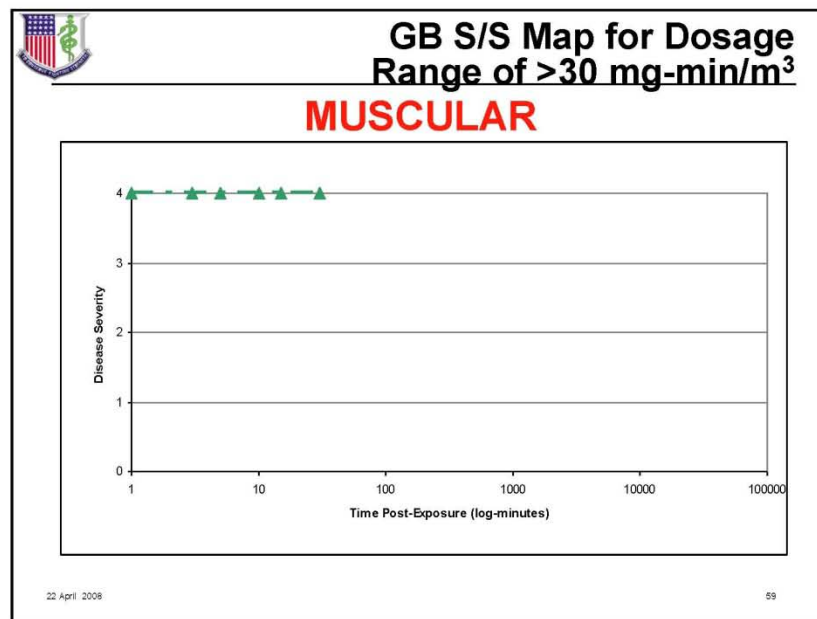
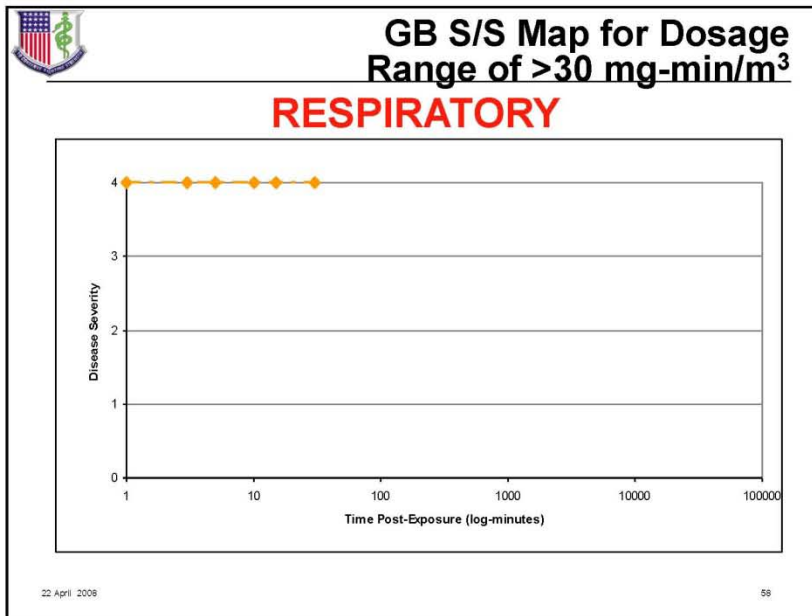


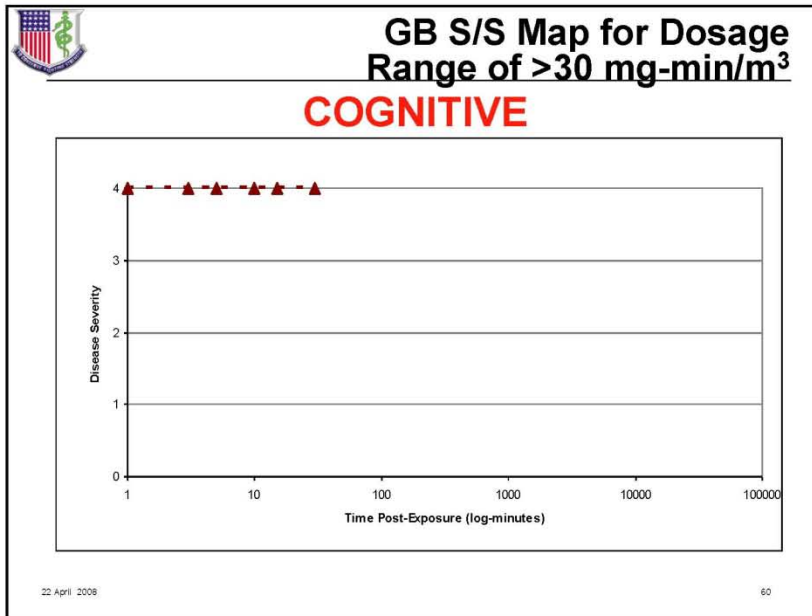









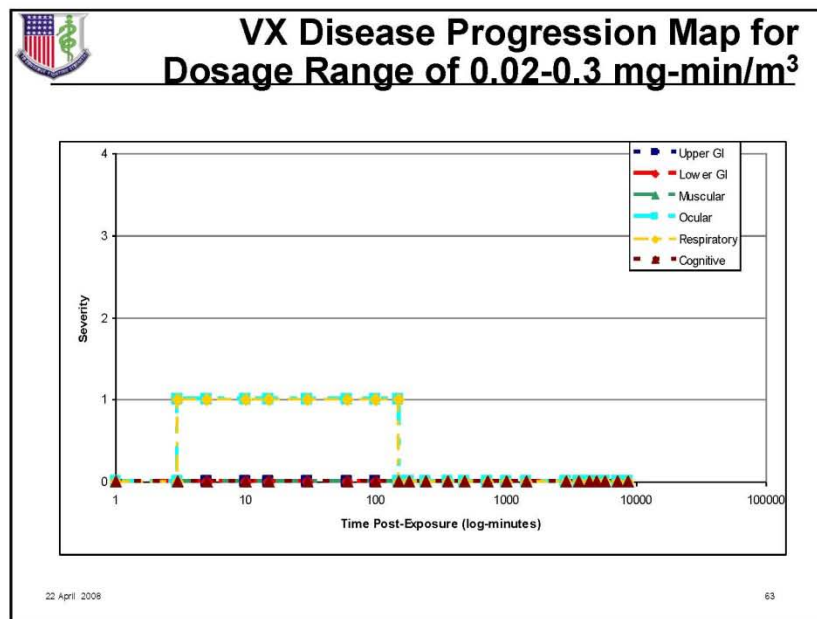
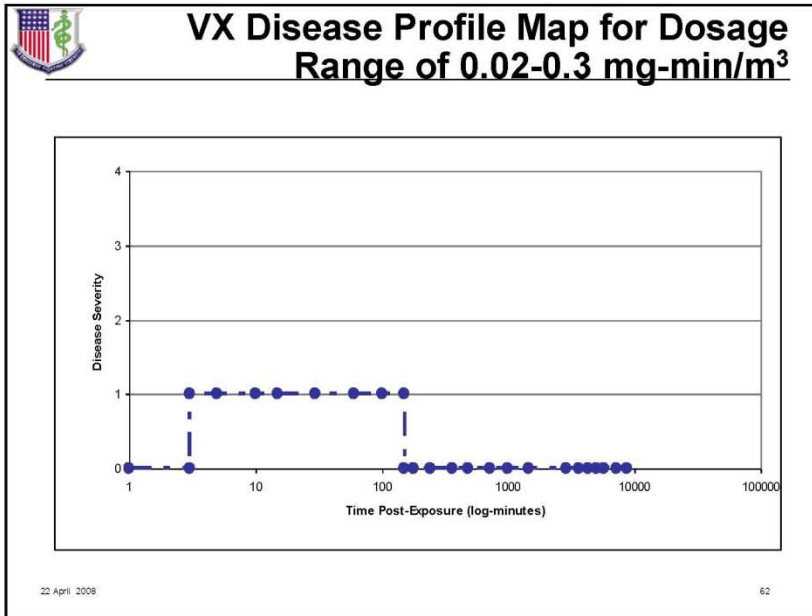


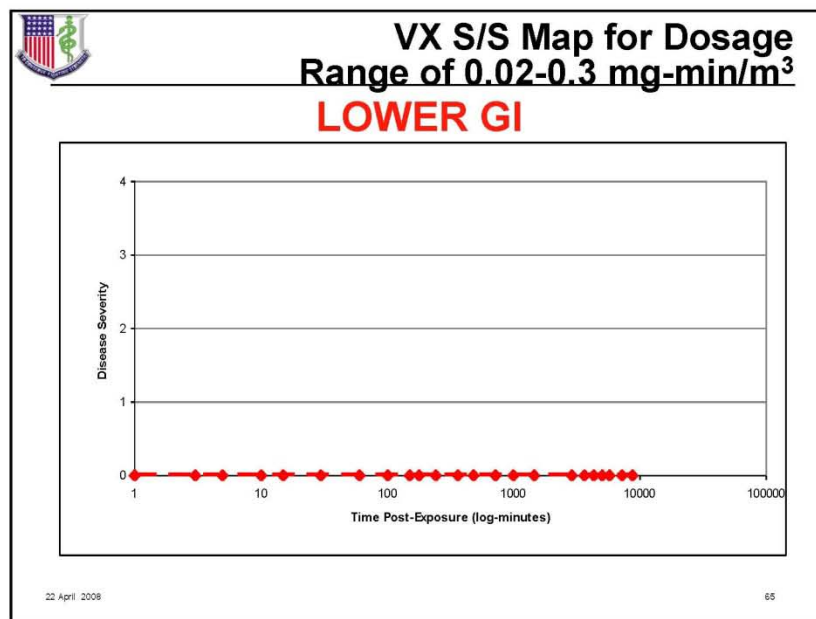
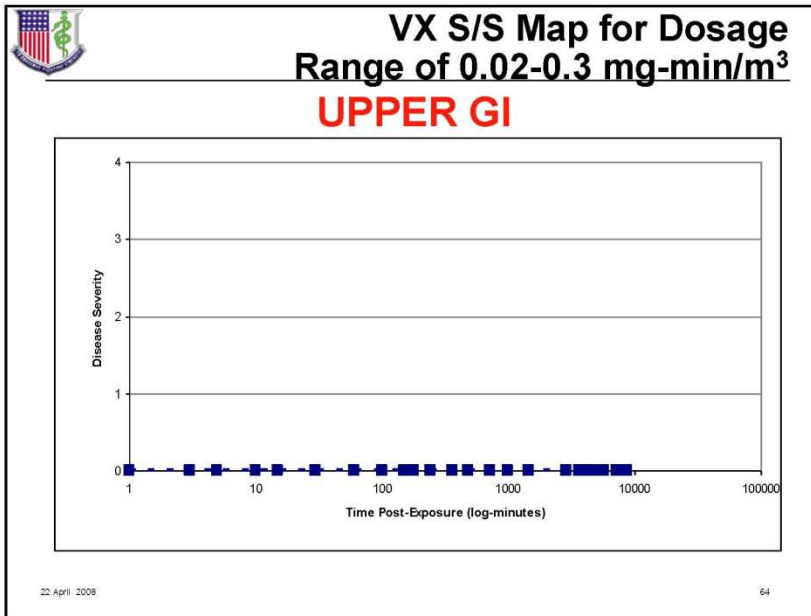


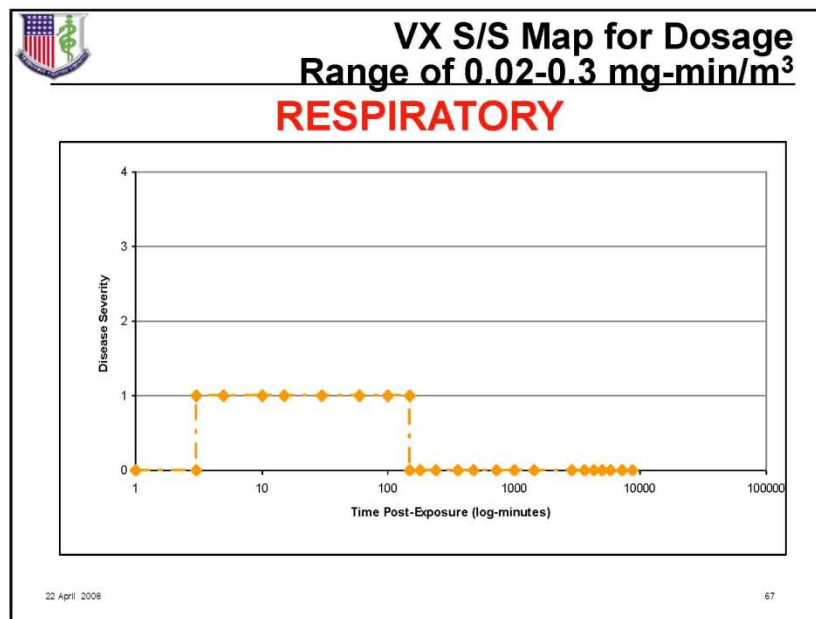
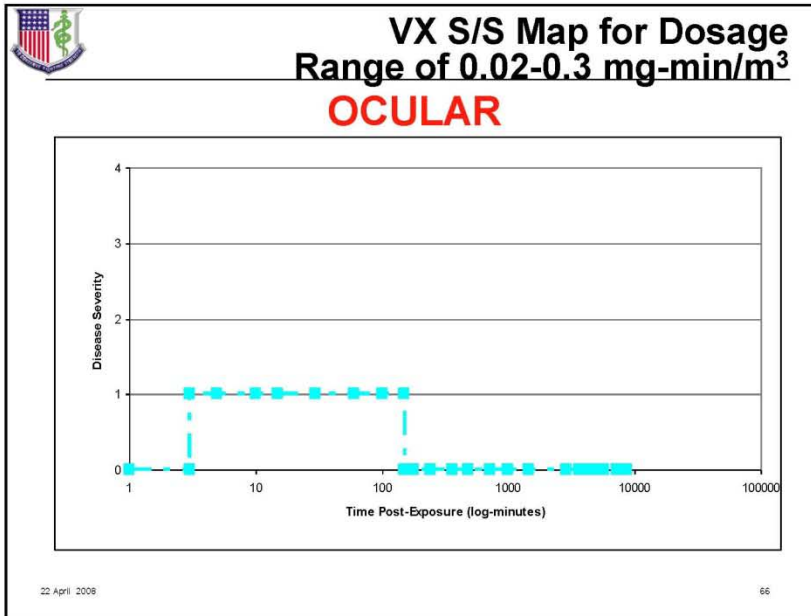
 **GB/VX Model Assumptions**

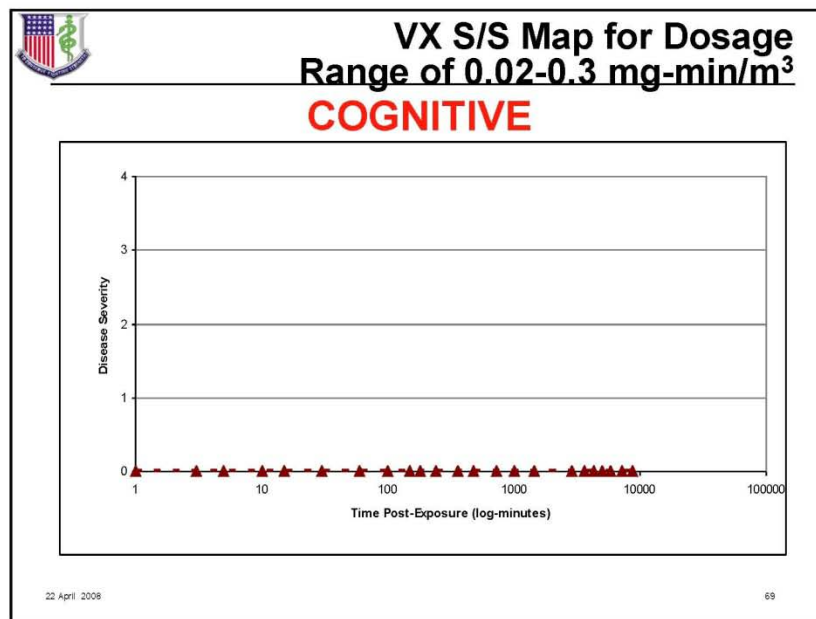
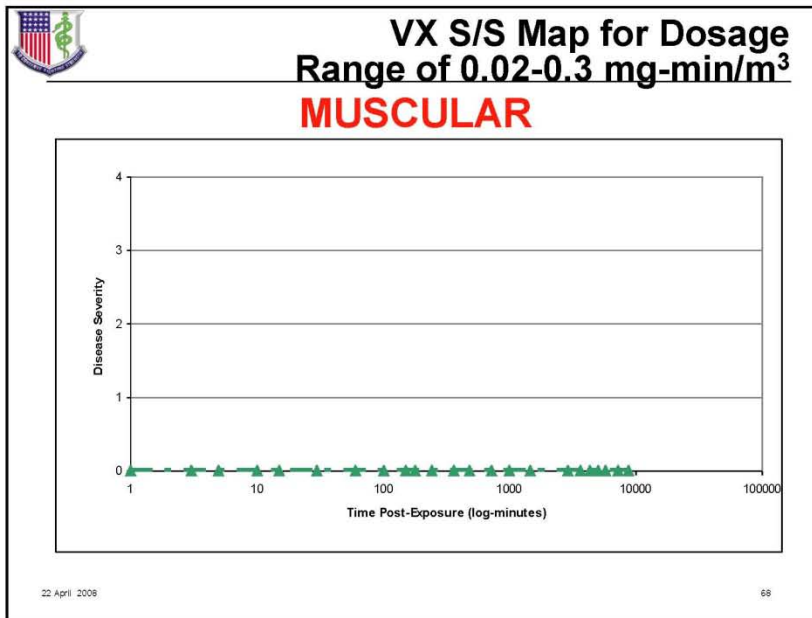
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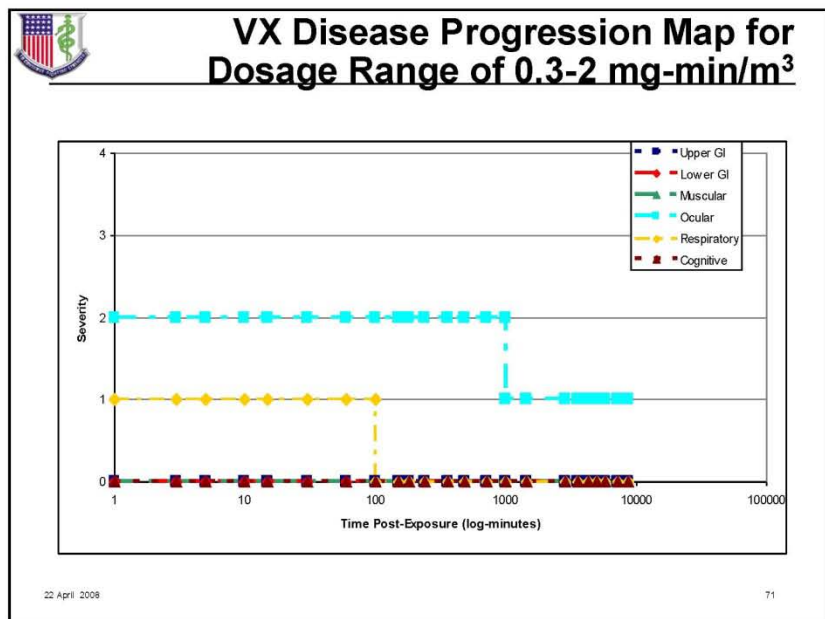
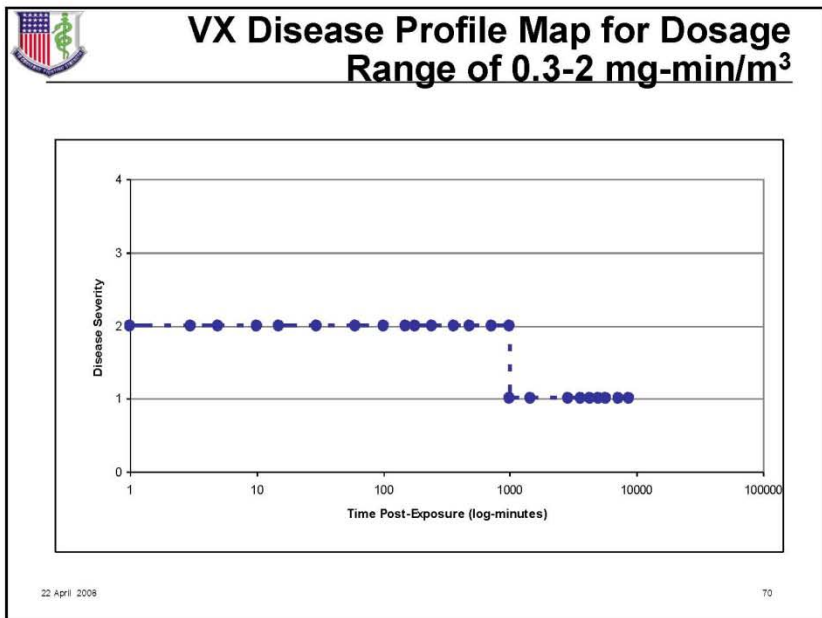
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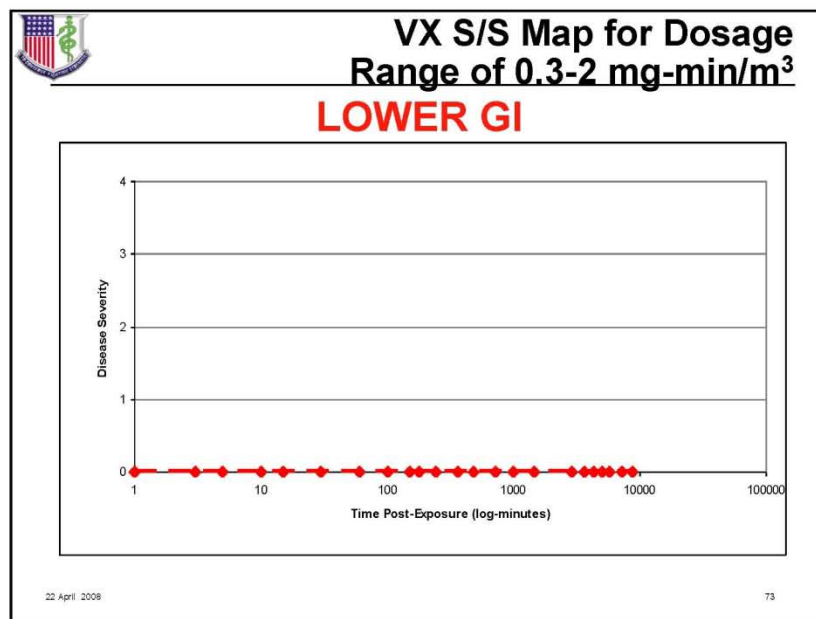
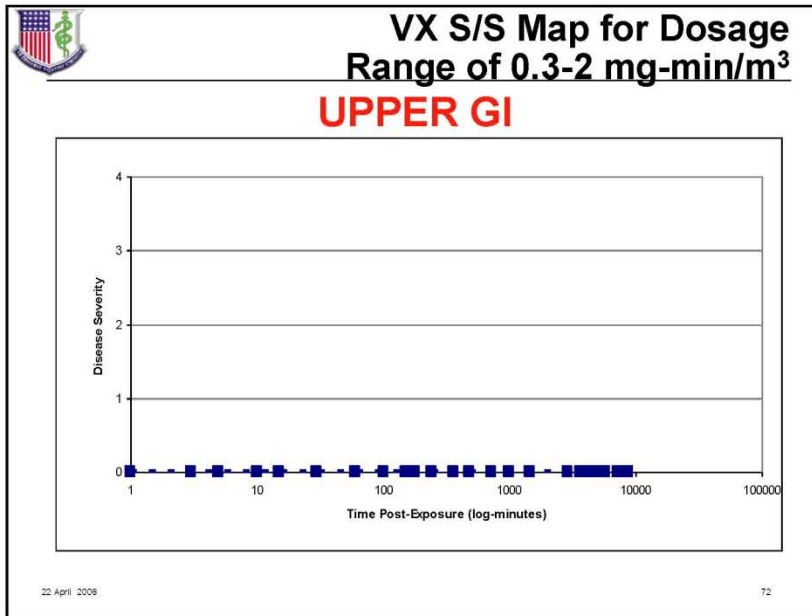


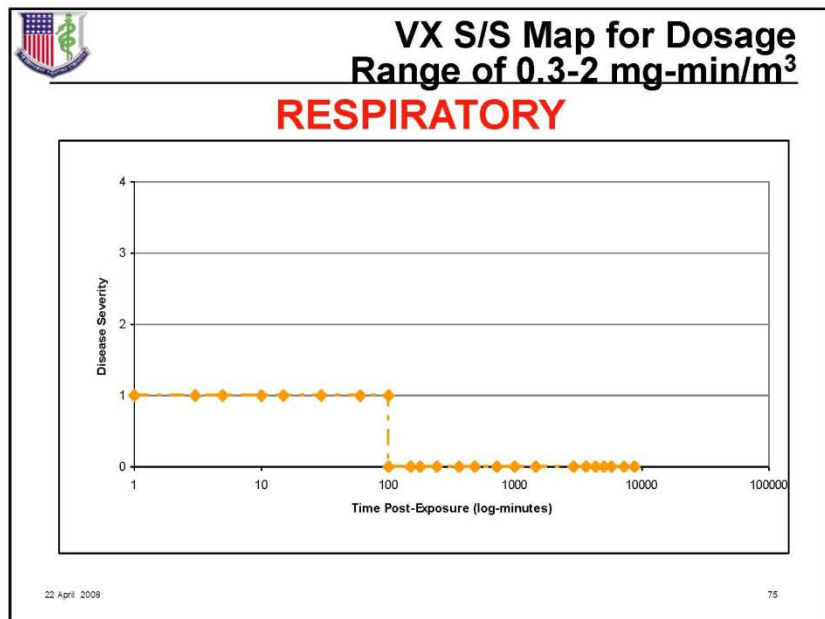
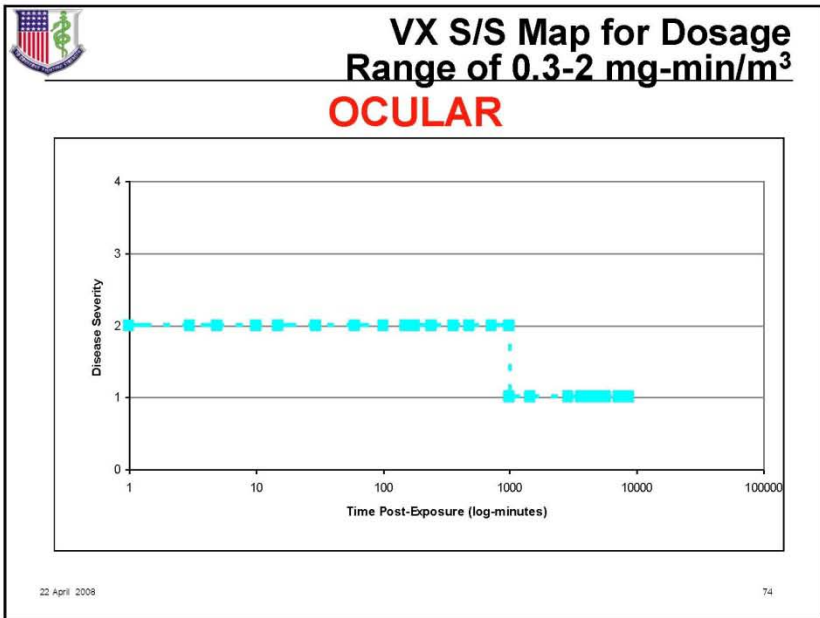


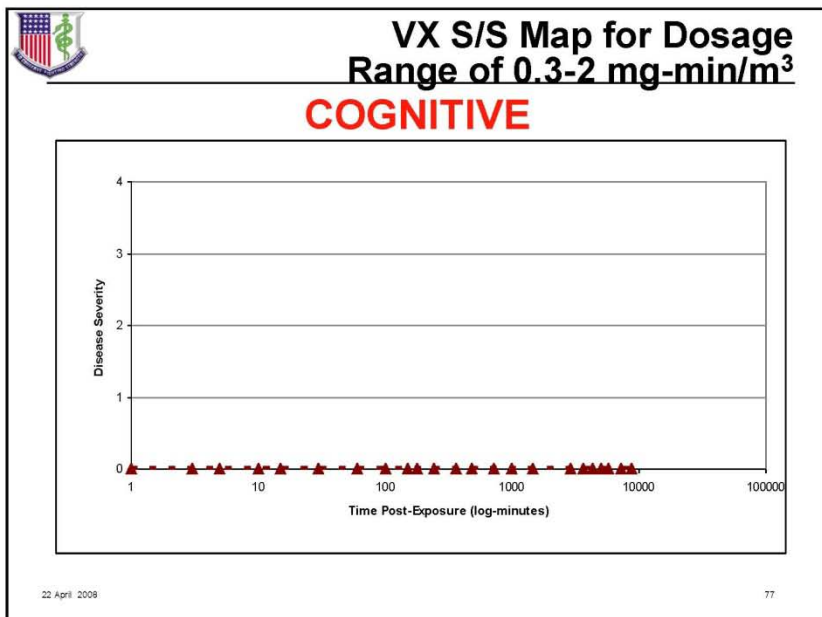
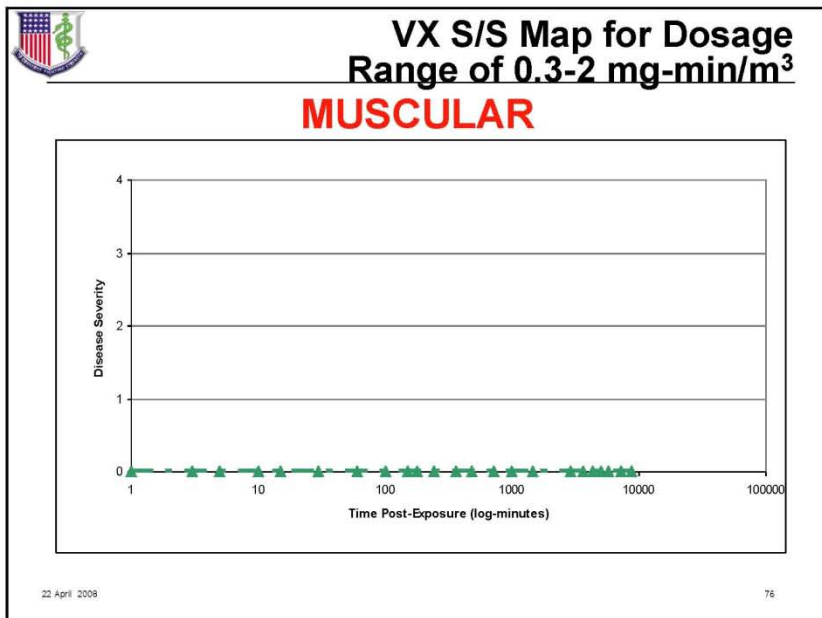






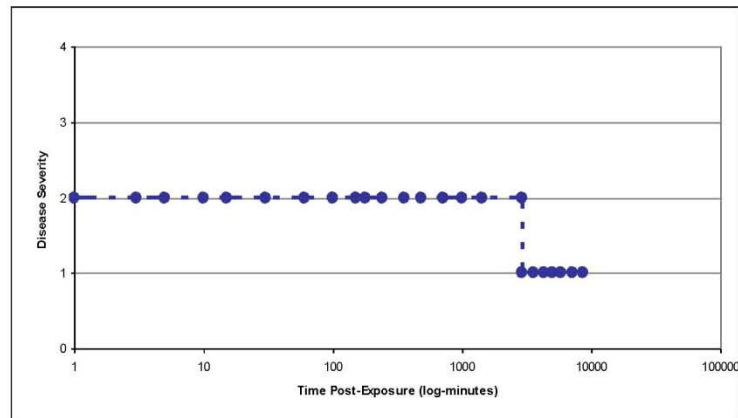








VX Disease Profile Map for Dosage Range of 2-4 mg-min/m³

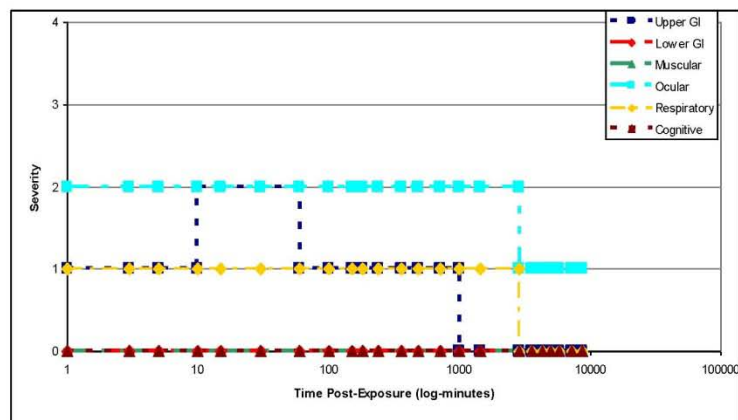


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VX Disease Progression Map for Dosage Range of 2-4 mg-min/m³



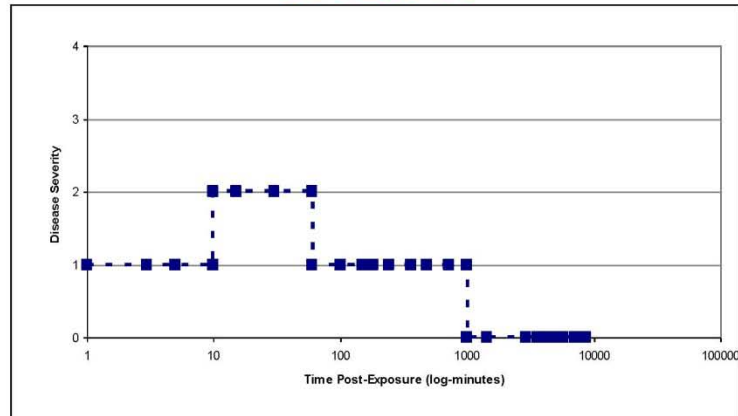
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VX S/S Map for Dosage Range of 2-4 mg-min/m³

UPPER GI



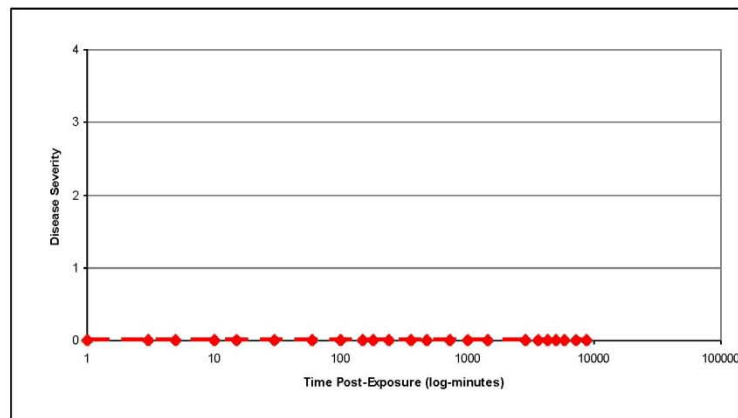
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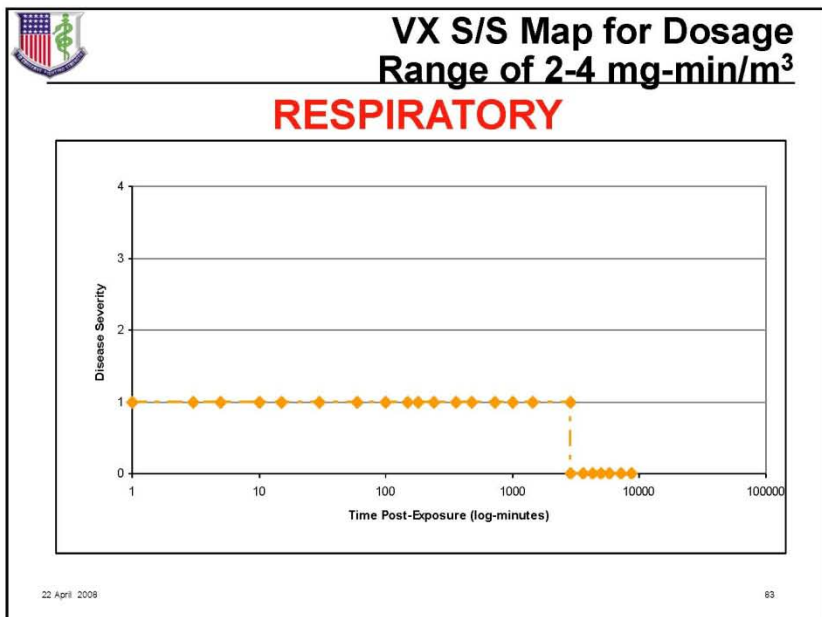
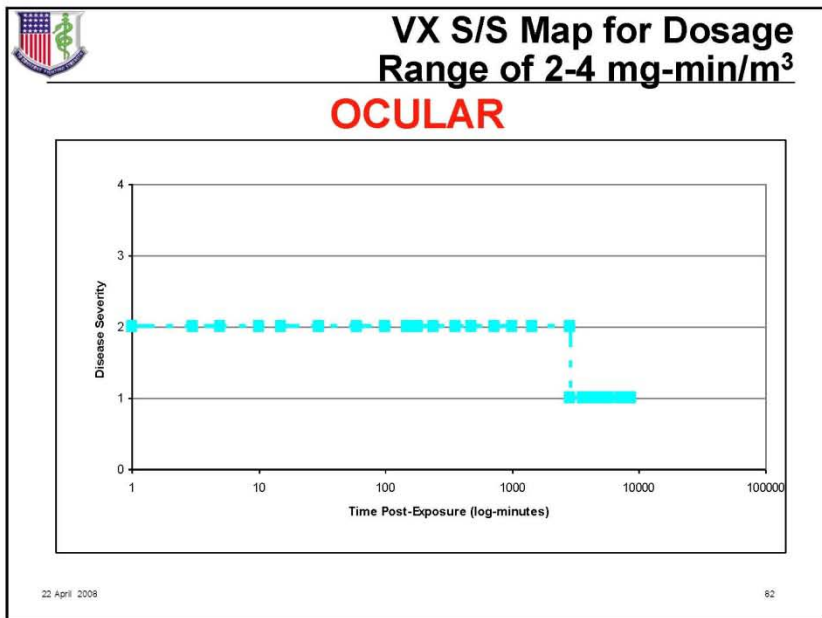
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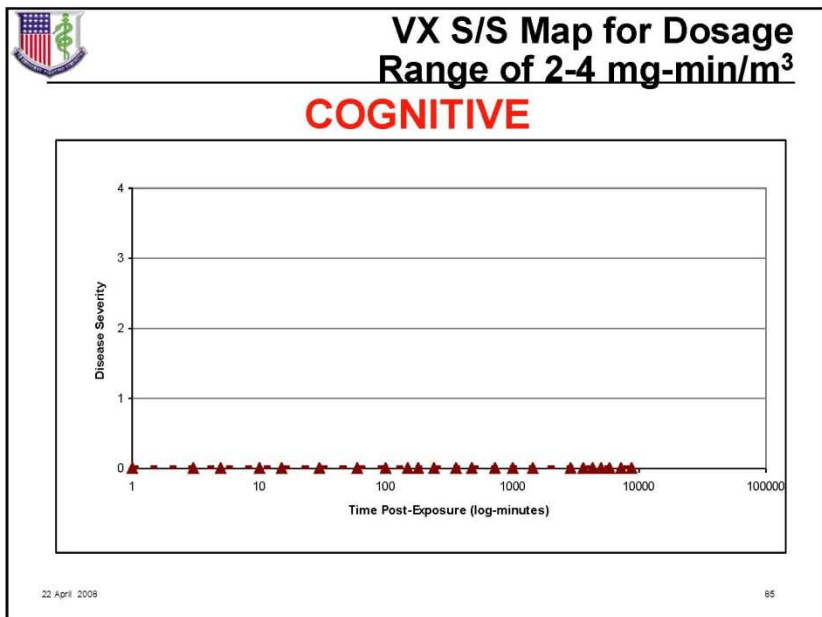
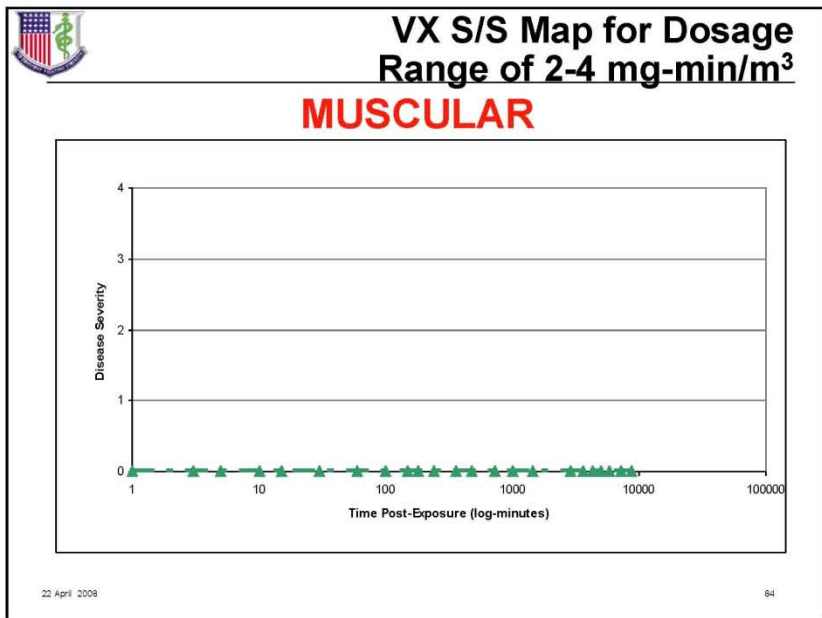
LOWER GI



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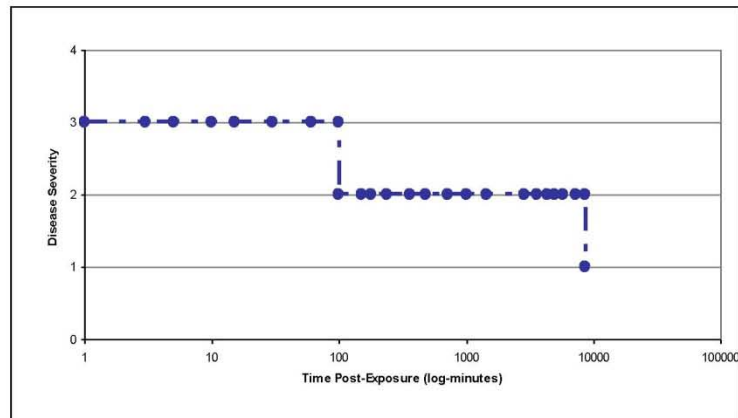
81







VX Disease Profile Map for Dosage Range of 4-10 mg-min/m³

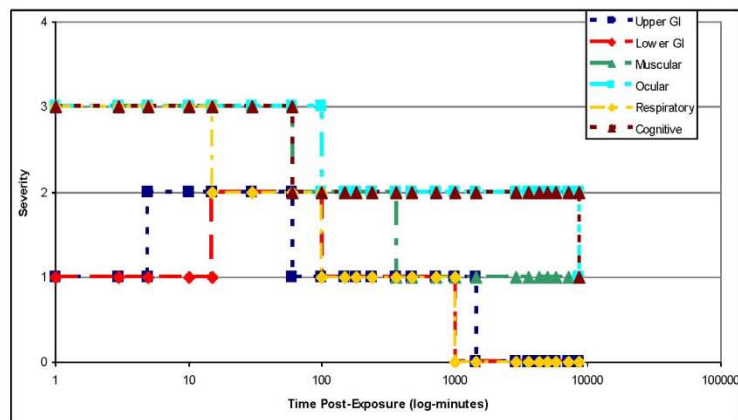


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VX Disease Progression Map for Dosage Range of 4-10 mg-min/m³



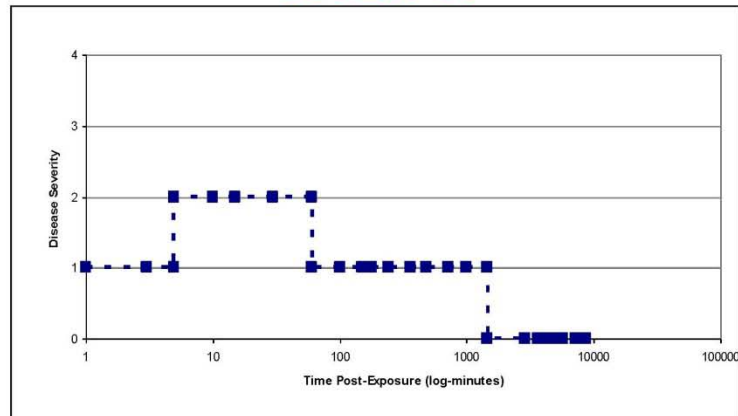
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VX S/S Map for Dosage Range of 4-10 mg-min/m³

UPPER GI



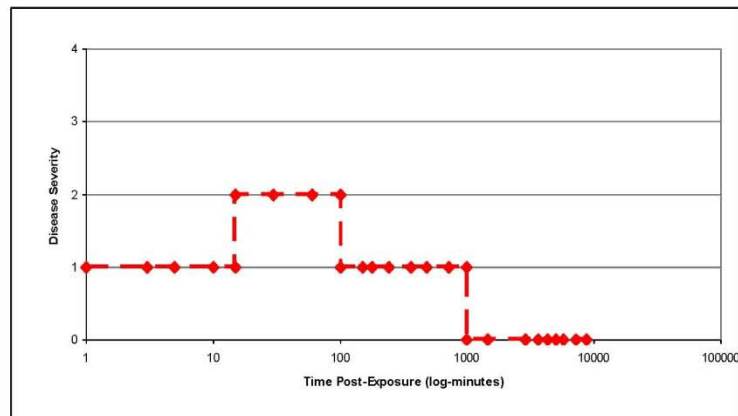
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VX S/S Map for Dosage Range of 4-10 mg-min/m³

LOWER GI



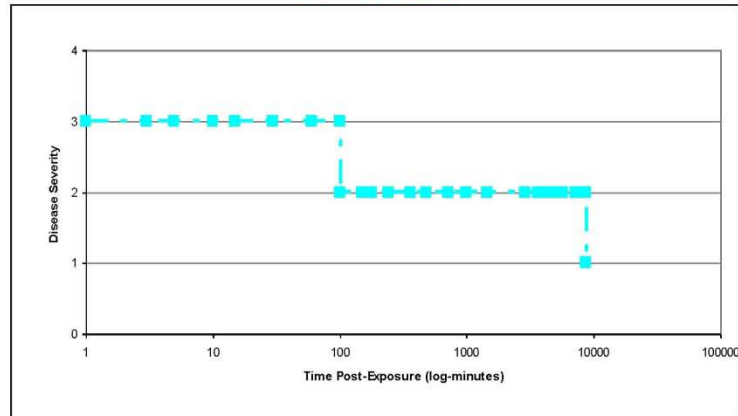
22 April 2008

89



VX S/S Map for Dosage Range of 4-10 mg-min/m³

OCULAR



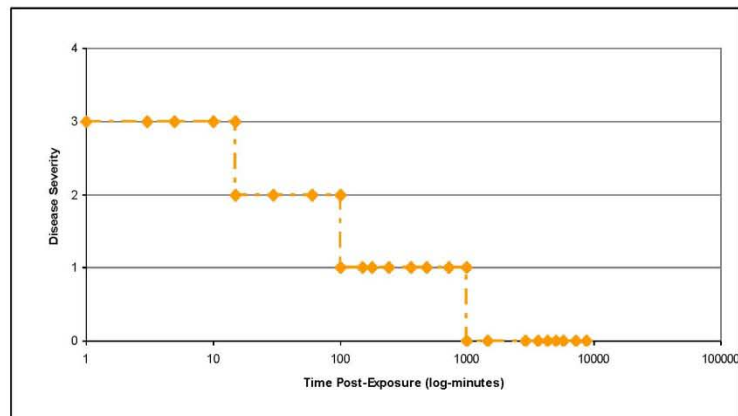
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90



VX S/S Map for Dosage Range of 4-10 mg-min/m³

RESPIRATORY



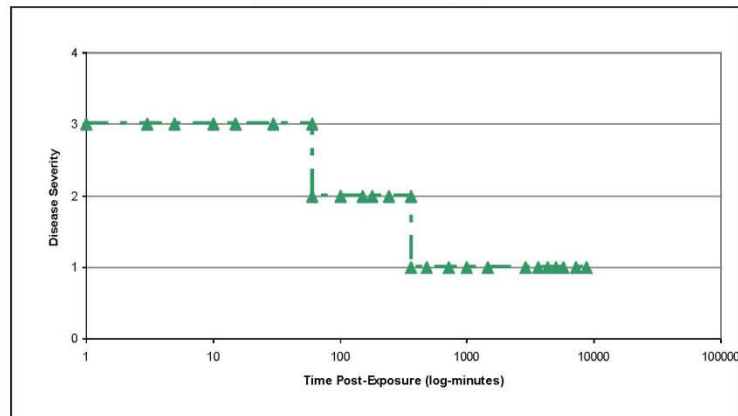
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VX S/S Map for Dosage Range of 4-10 mg-min/m³

MUSCULAR



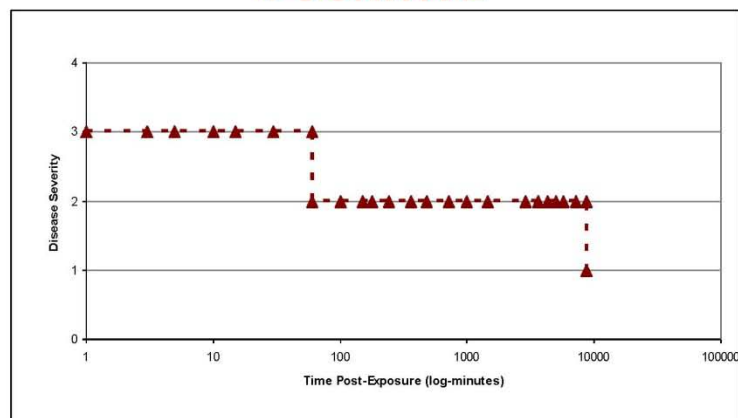
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VX S/S Map for Dosage Range of 4-10 mg-min/m³

COGNITIVE

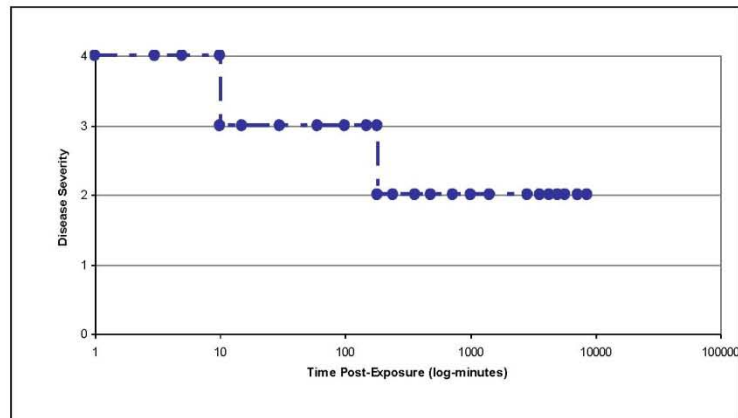


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VX Disease Profile Map for Dosage Range of 10-13 mg-min/m³

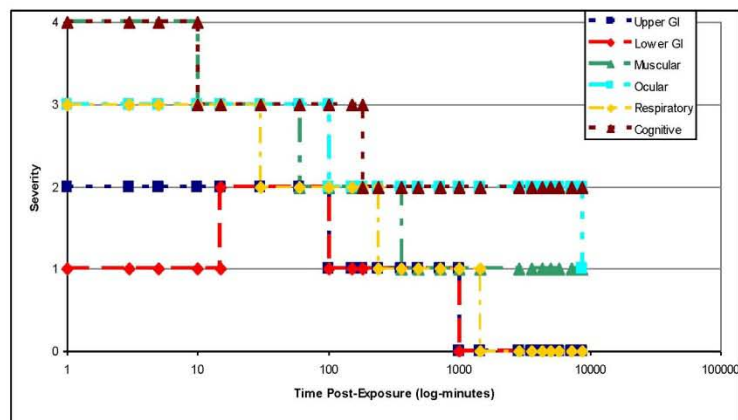


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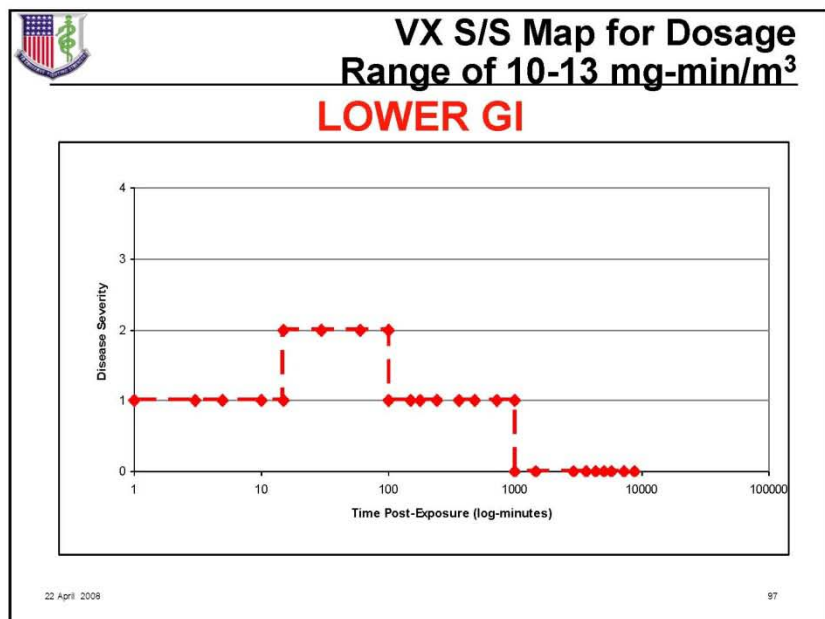
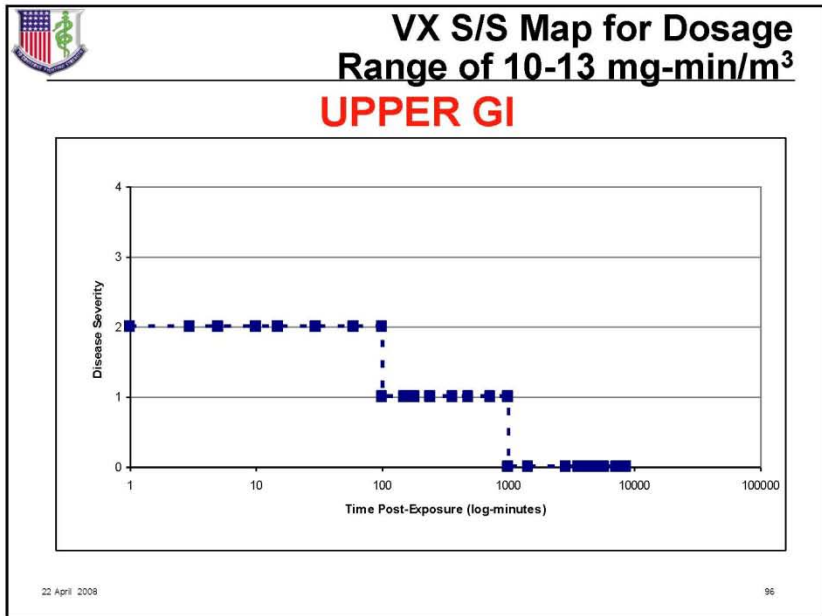


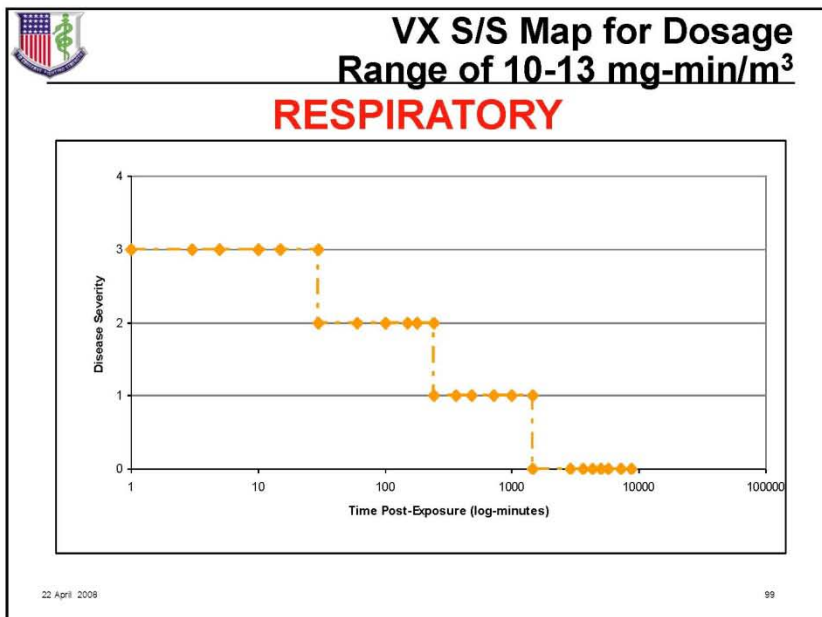
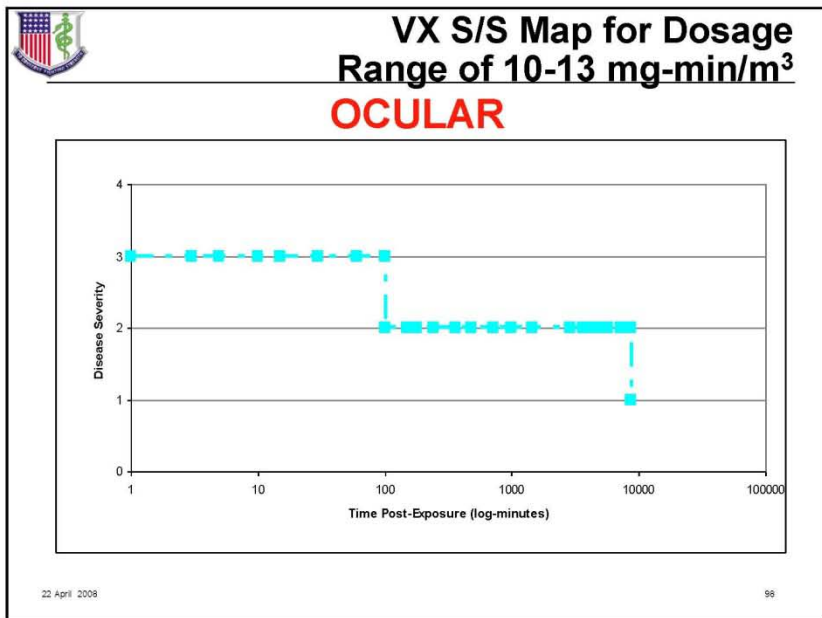
VX Disease Progression Map for Dosage Range of 10-13 mg-min/m³

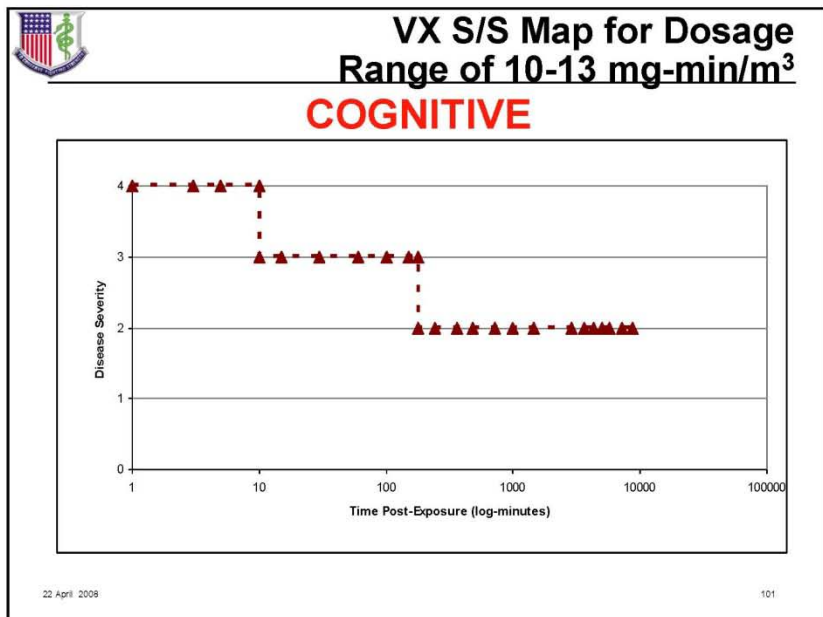
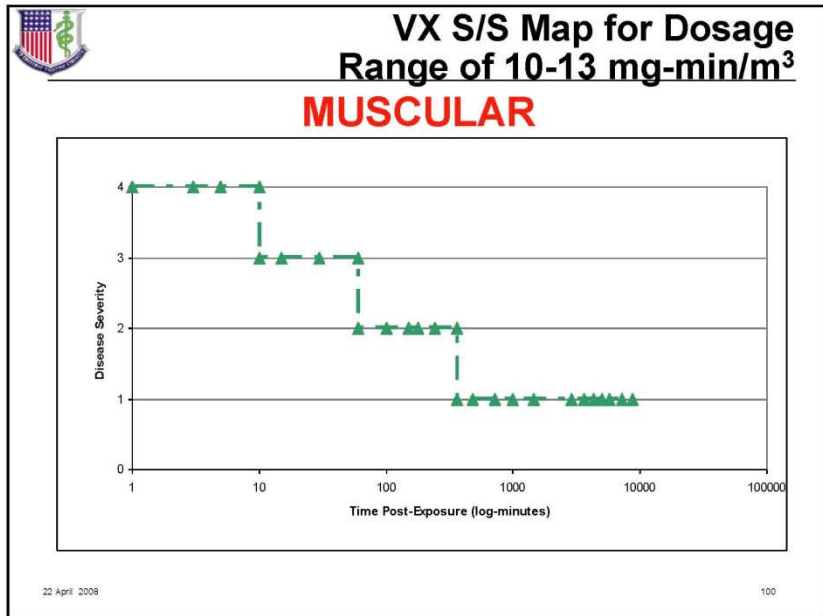


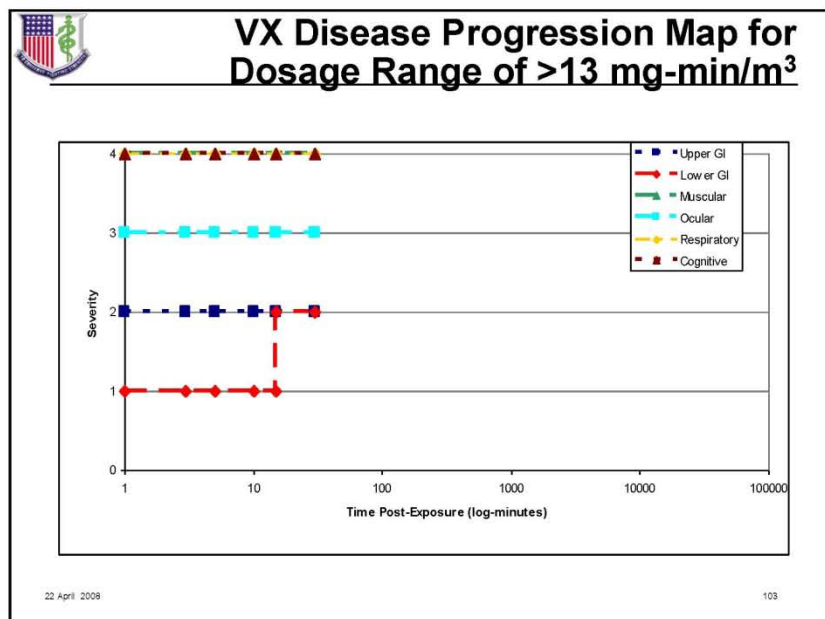
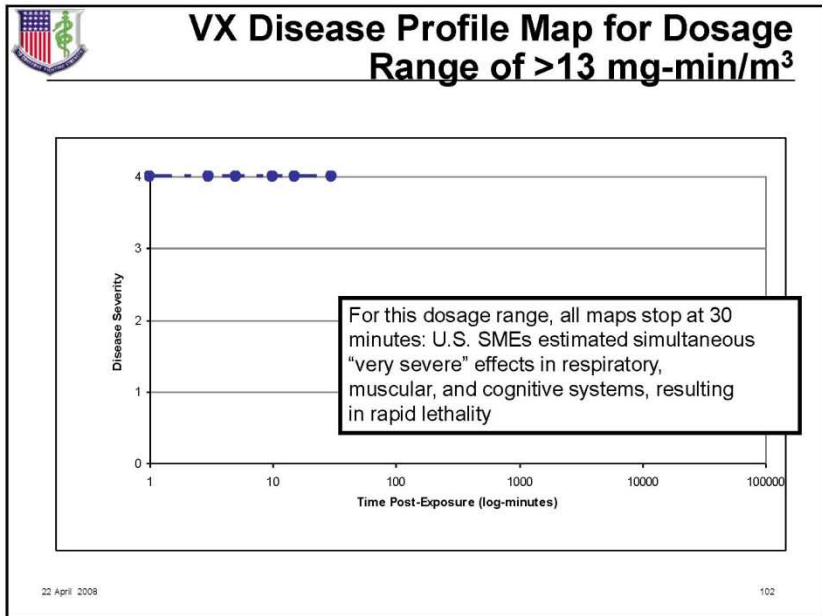
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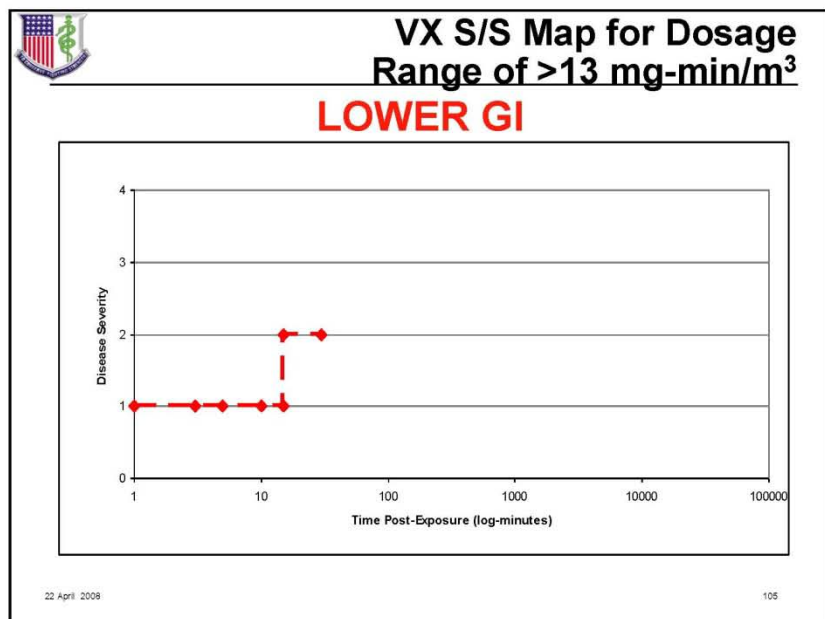
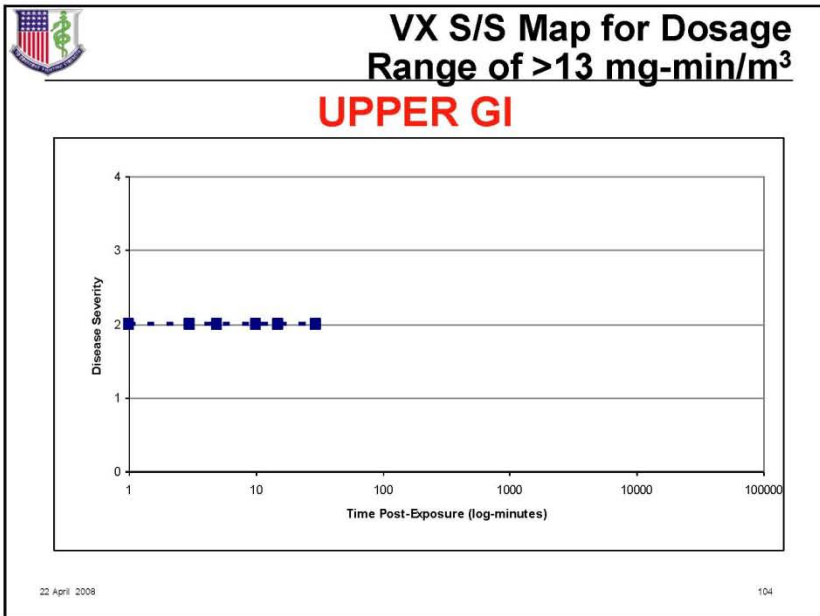
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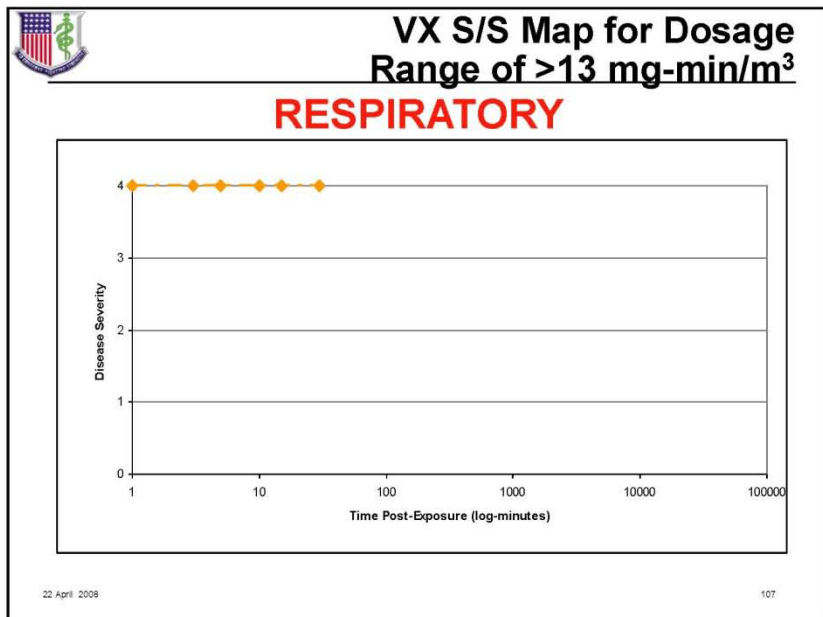
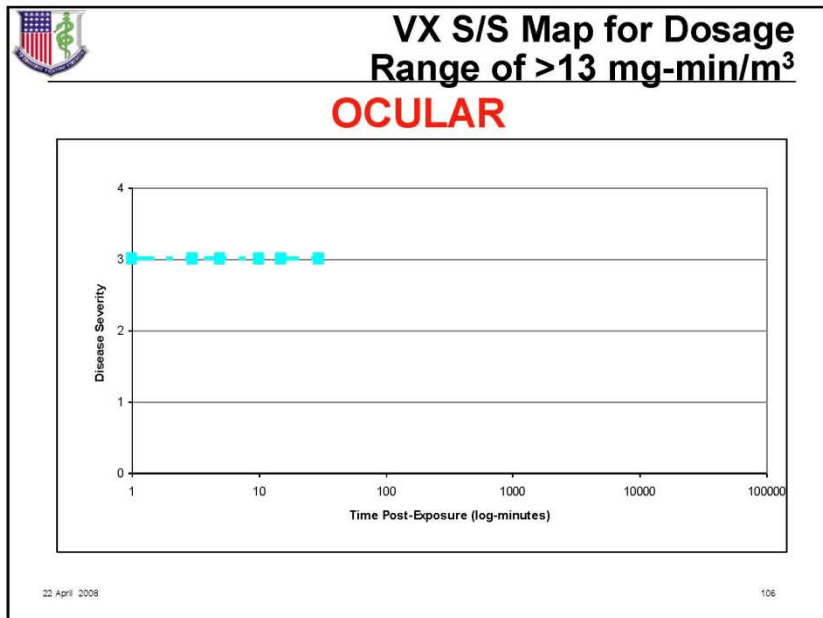


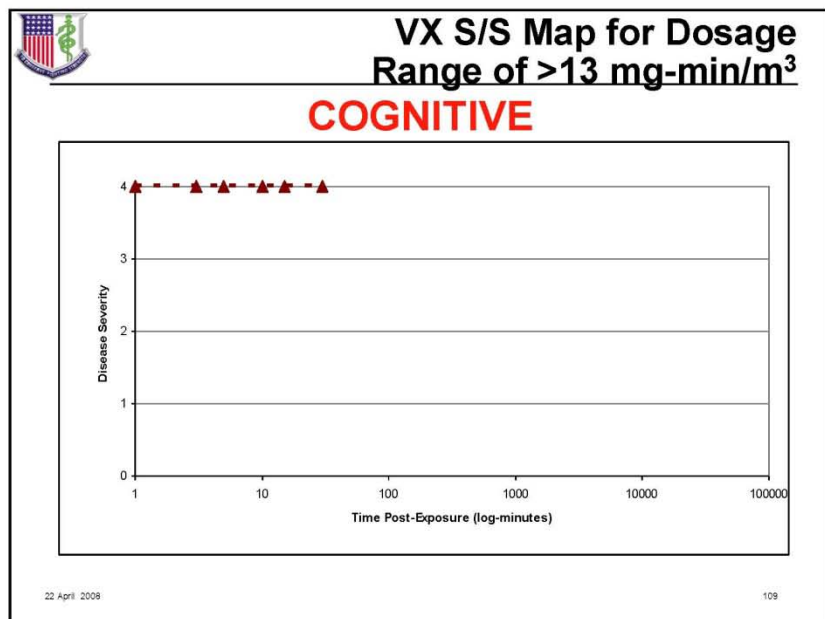
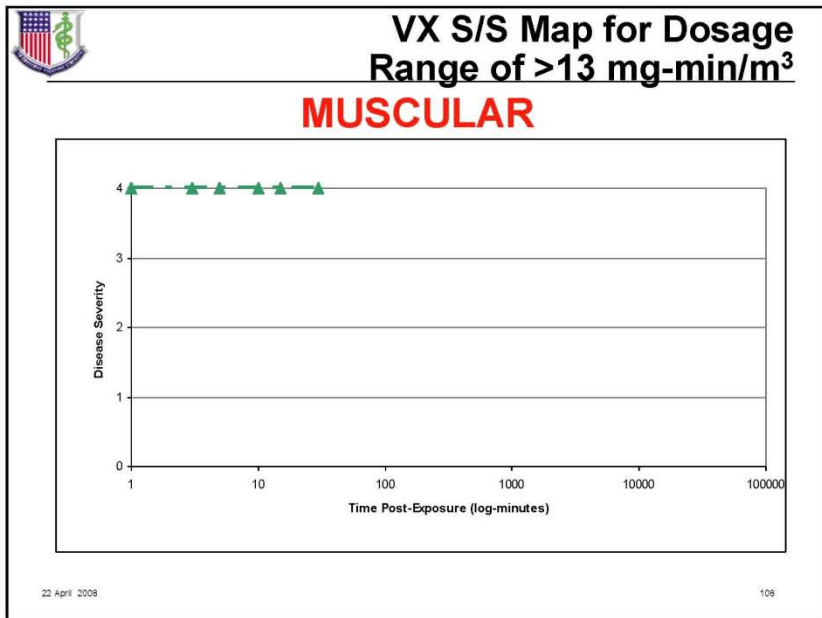














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Medical Planning Guide for CBRN Casualty Estimation
Subject Matter Expert Meeting – Chemical Human Response Models

Questions?



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F. Introduction to HD (Mustard) Agent Signs and Symptoms and Equivalent Dose – *Briefing*




Allied Medical Publication 8 (AMedP-8) SD.3 2008
Medical Planning Guide for CBRN Casualty Estimation
Subject Matter Expert Meeting – Chemical Human Response Models

***AMedP-8(C) NATO Planning Guide for the Estimation of
CBRN Casualties***

**Introduction to HD (Mustard)
Agent Signs and Symptoms
and Equivalent Dose**

Deena Disraelly
Carl Curling
Scott Weinrich
Bob Zirkle
Institute for Defense Analyses
22 April 2008



Briefing Outline

- Propose toxicity values for HD.
- Discuss the derivation of dosage ranges based on previous and proposed values.
- Describe equivalent dosage ranges and their clinically observable effects for HD.
- Discuss the equivalent dosage calculation.
- Describe the five severity levels and their associated effects on physiological systems (upper GI, respiratory, ocular, skin) following exposure to HD.
- Describe HD model assumptions.

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HD TOXICITY VALUES & DOSAGE RANGES

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Proposed Toxicity Values – HD

		LCt50/ECt50 Vapor: mg-min./m ³ OR LD ₅₀ /ED ₅₀ Liquid: mg	Probit Slope
Ocular	Mild (Vapor)	25	3
	Severe (Vapor)	75	3
Inhalation	Lethal (Vapor)	1000	6
Percutaneous	Mild (Vapor)	50	3
	Severe (Vapor)	500	3
	Severe (Liquid)	600	3
	Lethal (Vapor)	10000	7
	Lethal (Liquid)	1400	7

*Multiservice Publication,
FM 3-11.9/MCWP 3-
37.1B/NTRP
3-11.32/AFTTP(I) 3-2.55,
Potential Military
Chemical/Biological
Agents and Compounds.
January 2005*

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Proposed Toxicity Values – HD

		Proposed (from FM 3-11.9)		AMedP-8(B)	
		Median Toxicity (mg-min/m ³ or mg/man)	Probit Slope	Median Toxicity (mg-min/m ³ or mg/man)	Probit Slope
Ocular	Mild (Vapor)	25	3	25	2
	Severe (Vapor)	75	3	135	6
Inhalation	Lethal (Vapor)	1000	6	1000	6
Percutaneous	Mild (Vapor)	50	3	50	6
	Severe (Vapor)	500	3	2000	6
	Severe (Liquid)	600	3	1400	2
	Lethal (Vapor)	10000	7	10000	7
	Lethal (Liquid)	1400	7	7000	3

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Deriving Dosage Ranges – HD

HD – Ocular

	AMedP-8(B)	FM 3-11.9
Begin Dosage Range 1	0	0
End Dosage Range 1 -- Begin Dosage Range 2	5	4
10% Ocular Injury (ocular/mild)	6.3	9.35
50% Ocular Injury (ocular/mild)	25	25.00
End Dosage Range 2 -- Begin Dosage Range 3	50	26
10% Ocular Injury (ocular/severe)		28.05
End Dosage Range 3 -- Begin Dosage Range 4	70	50
10% Ocular Injury (ocular/severe)	81	
90% Ocular Injury (ocular/mild)	96	66.85
End Dosage Range 4 -- Begin Dosage Range 5	100	70
50% Ocular Injury (ocular/severe)	135	75.00
End Dosage Range 5 -- Begin Dosage Range 6	150	100
90% Ocular Injury (ocular/severe)	225	200.56

All values are dosages expressed in mg-min/m³

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Deriving Dosage Ranges – HD

HD – Respiratory & Upper GI

	AMedP-8(B)	FM 3-11.9
Begin Dosage Range 1	0	0
End Dosage Range 1 -- Begin Dosage Range 2	50	50
End Dosage Range 2 -- Begin Dosage Range 3	70	70
End Dosage Range 3 -- Begin Dosage Range 4	100	100
End Dosage Range 4 -- Begin Dosage Range 5	150	150
End Dosage Range 5 -- Begin Dosage Range 6	250	250
10% Lethal Effects due to Vapor Inhalation	600	611.52
50% Lethal Effects due to Vapor Inhalation	1000	1000.00
End Dosage Range 6 -- Begin Dosage Range 7	1200	1200
90% Lethal Effects due to Vapor Inhalation	1650	1635.28
Begin Respiratory Dose Range 8 [mg/man]		1400
50% Lethal Effects due to Liquid Percutaneous	7000	1400.00
90% Lethal Effects due to Liquid Percutaneous	18300	2134.06

All values are dosages expressed in mg-min/m³ except as noted for Cat. 8



Deriving Dosage Ranges – HD

HD – Skin

	AMedP-8(B)	FM 3-11.9
Begin Dosage Range 1	0	0
End Dosage Range 1 -- Begin Dosage Range 2	25	12
10% Threshold Effects - Vapor	30	18.70
50% Threshold Effects - Vapor	50	50.00
90% Threshold Effects - Vapor	82	
End Dosage Range 2 -- Begin Dosage Range 3	100	
End Dosage Range 3 -- Begin Dosage Range 4	250	125
90% Threshold Effects - Vapor		133.71
End Dosage Range 4 -- Begin Dosage Range 5	500	
End Dosage Range 5 -- Begin Dosage Range 6	750	180
10% Severe Effects - Vapor	1190	186.98
End Dosage Range 6 -- Begin Dosage Range 7	1500	300
50% Severe Effects - Vapor	2000	500.00
90% Severe Effects - Vapor	3300	1337.07
End Dosage Range 7 -- Begin Dosage Range 8	4000	1800
10% Lethal Effects - Vapor	6500	6560.26
50% Lethal Effects - Vapor	10000	10000.00
End Dosage Range 8 -- Begin Dosage Range 9	12000	12000
90% Lethal Effects - Vapor	15300	15243.29

All values are dosages expressed in mg-min/m³



Dosage Ranges – HD Ocular

HD Dosage Range (mg-min/m ³)	Description
0 - 4	No observable effect.
4 - 26 26 - 50	Eyes sting, tears, blurred vision; 10% have mild ocular effects at 9 mg-min/m ³ ; 50% at 25 mg-min/m ³ ; 10% have severe ocular effects at 28 mg-min/m ³ .
50 - 70	Eyes feel gritty and sensitive to light, non-stop tears flood eyes; 90% have mild ocular effects at 67 mg-min/m ³ .
70 -100	Eyelids are puffy, and eyes burn; eyes are too painful to keep open; 50% have severe ocular effects at 75 mg-min/m ³ .
> 100	Eyelids are swollen shut and burning, eyes are too painful to open; 90% have severe ocular effects at 200 mg-min/m ³ .

Tables derived from DICE methodology; toxicity values updated to reflect current values

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Dosage Ranges – HD Respiratory & Upper GI

HD Dosage Range (mg-min/m ³)	Description
0 – 50	No injury.
50 – 70	Nauseated, swallows often.
70 – 100	Dry mouth, dry cough, sneezing, runny nose, headache, nauseated, vomited once or twice; 10% have severe effects at 80 mg-min/m ³ .
100 - 150	Sore throat, continuous cough, hoarseness, chest feels tight, headache, fever; 50% have severe effects at 135 mg-min/m ³ .
150 - 250	Hurts to breathe, hacking cough, cannot speak, headache, dry heaves, fatigued from vomiting; 90% have severe effects at 230 mg-min/m ³ .
250 - 1200	Awful chest pain, wheezing and shortness of breath, coughs up red colored mucous; 10% die at 600 mg-min/m ³ and 50% mortality at 1000 mg-min/m ³ .
>1200	Very severe effects; 90% mortality at 1700 mg-min/m ³ .
Dosage Range (mg/man)	Description
> 1400	Very severe effects, including bone marrow suppression due to liquid dosage; >50% lethal effects at 1400 mg/man.

Tables derived from DICE methodology; toxicity values updated to reflect current values

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Dosage Ranges – HD skin

HD Equivalent Dosage Range (mg-min/m ³)	Description
0 - 12	No observable effect.
12 - 125	Skin sensitive to touch in tender areas (crotch, armpits, inside of elbow and knee); threshold effects in 10% at 19 mg-min/m ³ , in 50% at 50 mg-min/m ³ .
125 - 180	Skin sore in tender areas; painful when moving; red body skin; tiny blisters on hands and neck; 90% have threshold effects at 134 mg-min/m ³ .
180 - 300	Skin raw and painful tender areas; red, swollen body skin; large blisters on hands and neck; 10% have severe effects at 187 mg-min/m ³ .
300 -1800	Skin peels off leaving open raw areas and painful ulcers in tender areas; 50% have severe body skin effects at 500 mg-min/m ³ ; 90% at 1337 mg-min/m ³ .
1800 - 12000	10% die at 6560 mg-min/m ³ exposure over whole body; 50% die at 10,000 mg-min/m ³ exposure over whole body.
> 12000	90% die at 15,243 mg-min/m ³ exposure over whole body.

Tables derived from DICE methodology; toxicity values updated to reflect current values

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HD EQUIVALENT DOSAGE CALCULATION

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Agent Routes of Exposure

	Vapor		Liquid
	Inhalation	Percutaneous	Percutaneous
Ocular		X	
Respiratory	X		
Upper Gastrointestinal	X		
Skin		X	X

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Calculating Equivalent Dosages – HD

Vapor Dosage for HD (ocular and inhalation):

$$D_{HD} = D_{\text{vapor}}$$

Equivalent Dosage Calculation for HD (skin only):

$$ED_{HD} = D_{\text{vapor}} + D_{\text{liquid}} F_d$$

$$F_d = EC_{t_{50(HD/PC/V)}} / ED_{50(HD/PC/L)} = 500/600 = 0.833 \text{ min/m}^3$$

HD/PC/V = HD/Percutaneous/Vapor

HD/PC/L = HD/Percutaneous/Liquid

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HD SIGNS/SYMPTOMS SEVERITY


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Severity Definitions

Degrees		Description
0	N.O.E.	No observable effect
1	Mild	Disease or wounds manifesting signs and symptoms of such severity that individuals can care for themselves or be helped by untrained personnel and their ability to conduct the assigned mission may or may not be impacted by the manifested signs and symptoms.
2	Moderate	Disease or wounds manifesting signs and symptoms of such severity that medical care may be required; general condition permits treatment as outpatient and some continuing care and relief of pain may be required before definitive care is given; condition may be expected to interrupt or preclude ability to conduct the assigned mission.
3	Severe	Disease or wounds manifesting signs and symptoms of such severity that there is cause for immediate concern but there is no imminent danger to life; individual is acutely ill and likely requires hospital care. Indicators are questionable – condition may or may not reverse without medical intervention; individual is unable to conduct the assigned mission due to severity of signs and symptoms.
4	Very Severe	Disease or wounds manifesting signs and symptoms of such severity that life is imminently endangered. Indicators are unfavorable – condition may or may not reverse even with medical intervention; prognosis is lethality without medical intervention; individual is unable to conduct the assigned mission and is unexpected to return to the mission due to severity of signs and symptoms.

 HD S/S Severities		
Signs / Symptoms Severity	Upper GI Signs/Symptoms	Respiratory Signs/Symptoms
0	No observable effect	No observable effect
1	Upset stomach and nausea; watering mouth and frequent swallowing to avoid vomiting	Mild shortness of breath; tight chest, coughing, and runny nose (rhinorrhea)
2	Episodes of vomiting, possibly including dry heaves; severe nausea and possibility of continued vomiting	Frank shortness of breath; difficult to breathe, wheezing breath, respiratory congestion, bronchorrhea
3		Breathing sporadically stops and starts, skin has a purple or blue color, hemoptysis
4		Breathing stops completely or struggling to breathe; prostration
<div> <div>22 April 2008</div> <div>16</div> </div>		

 HD S/S Severities		
Signs / Symptoms Severity	Ocular Signs/Symptoms	Skin Signs/Symptoms
0	No observable effect	No observable effect
1	Slightly blurred, dim (may be due to tearing), or possibly irritated (conjunctival erythema and/or edema) vision	Itchy skin; skin sensitive to touch in crotch, armpits, and on inside of elbow and knee joints
2	Blurred vision due to dimming or difficulty opening eyes; eyes sensitive to light or puffy; potential for pressure behind the eyes, eye pain, or heavy tearing	Skin sore in crotch, armpits, elbow and knee joints, and painful when moving; red swollen skin, tiny blisters on hands and neck
3	Functional blindness (possibly accompanied by extreme headache)	Possible skin sloughage; large blisters or swollen skin; skin raw and painful in crotch, armpits, elbow and knee joints
4		
<div> <div>22 April 2008</div> <div>17</div> </div>		



HD MODEL ASSUMPTIONS

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Overarching Model Assumptions

- Human response can be modeled over time as a function of dose-related effects (signs and symptoms).
 - Dose-related effects apply for all doses in a specified dose range.
- Human response to an exposure can be represented by the median individual in each dose/dosage/exposure band.
- Toxic Load Exponent = 1; Haber's Law applies.
 - Human response to cumulative dosages/doses (regardless of exposure length in the exposure models) is the function of 2-min exposures.
 - Individual disease profiles begin after completion of exposure, as expressed in the exposure model.
- Prior to exposure, individuals are in perfect health.
- 70 kilogram man, breathing 15 liters per minute.

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HD Specific Model Assumptions

- Ocular disease is assumed to result only from vapor exposures.
 - This is based on the assumption that personnel will shield their eyes from liquid HD droplets.
- Upper gastrointestinal and respiratory effects are assumed to only result from the inhaled vapor dosages, with the exception of respiratory effects resulting from bone marrow suppression following high levels of percutaneous liquid exposure.
- The skin dosages and doses resulting from exposure to percutaneous vapor (HD) and percutaneous liquid (HD) can be equated to a single equivalent skin dosage through a ratio method.
 - The equivalent dosage is the equivalent vapor dosage that would result in similar disease progression—signs and symptoms over time—as actual combination of dosages and doses to which the individual was exposed.
 - This assumption allows for an approximation of dosage as a basis for the estimation of human response.
- The disease progressions resulting from percutaneous vapor and percutaneous liquid are similar.
 - This assumption builds on the previous one, in that if it is assumed that an equivalent dosage can be calculated, the disease progression should follow the equivalent vapor dosage.

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Questions?



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G. HD (Mustard) Response: Signs and Symptoms Over Time as a Function of Dose – Briefing




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**HD (Mustard) Response:
Signs and Symptoms Over Time
as a Function of Dose**

Carl Curling
Deena Disraeli
Scott Weinrich
Bob Zirkle
Institute for Defense Analyses
22 April 2008



Briefing Outline

- Review the five severity levels and their associated effects on physiological systems (upper GI, respiratory, ocular, skin) following exposure to HD.
- Present disease progression maps displaying the severity levels across time for each system at each exposure/dosage range for HD.
- Describe possible ranges for which dose ranges could be collapsed.

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HD DISEASE PROGRESSION MAPS

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2

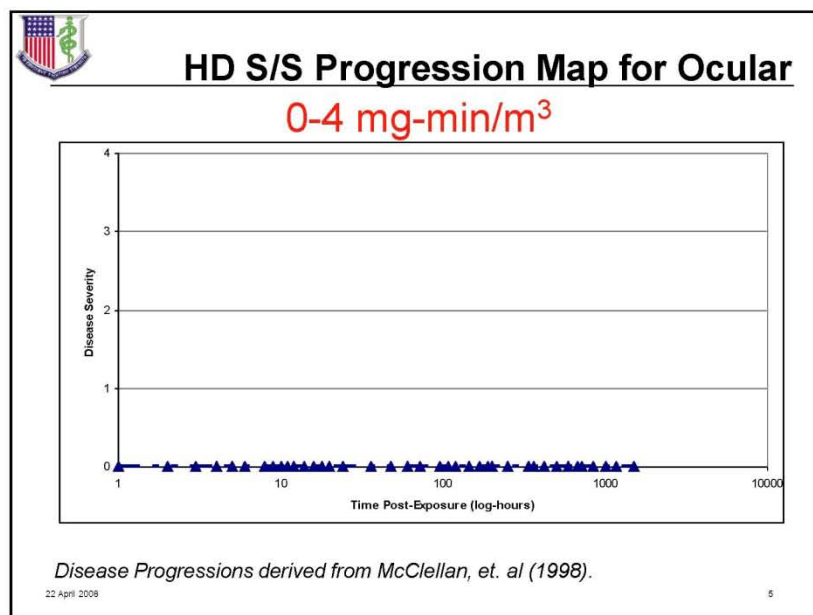
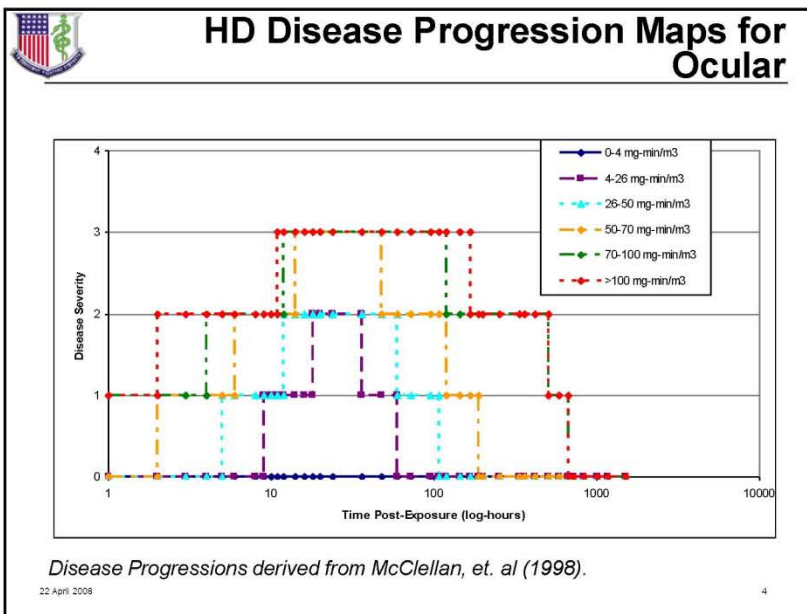


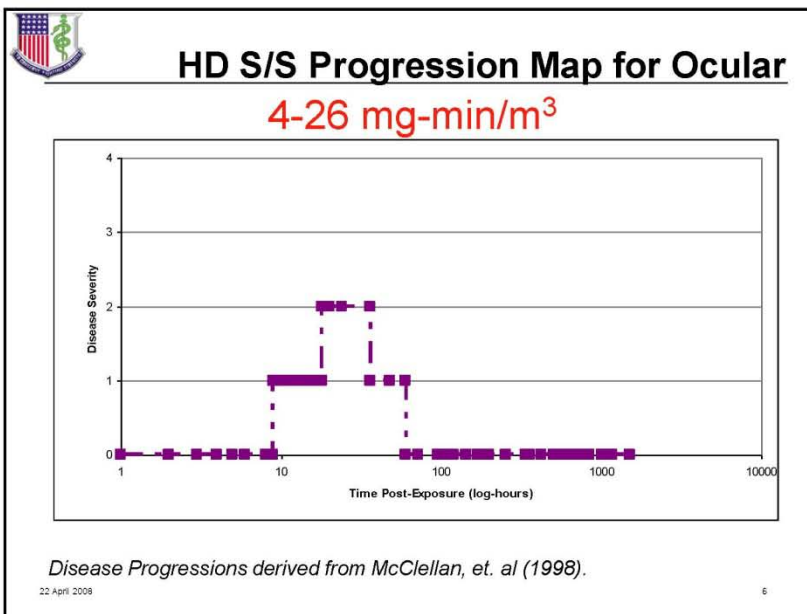
HD S/S Severity

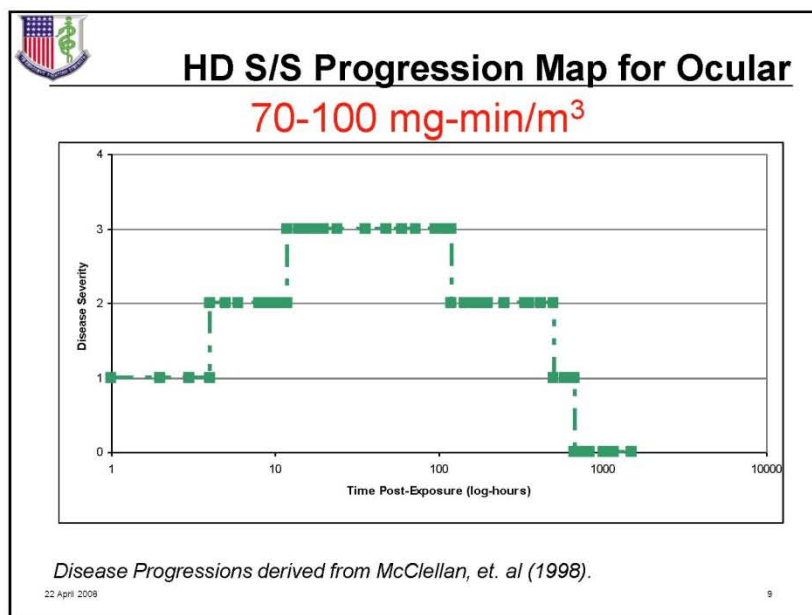
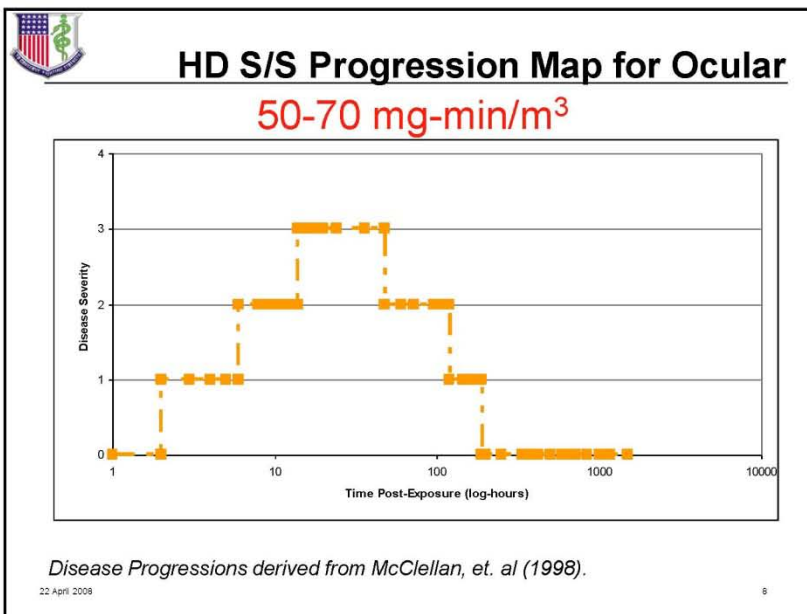
Signs / Symptoms Severity	Ocular Signs/Symptoms
0	No observable effect
1 Mild	Slightly blurred, dim (may be due to tearing), or possibly irritated (conjunctival erythema and/or edema) vision
2 Moderate	Blurred vision due to dimming or difficulty opening eyes; eyes sensitive to light or puffy; potential for pressure behind the eyes, eye pain, or heavy tearing
3 Severe	Functional blindness (possibly accompanied by extreme headache)
4 Very severe	

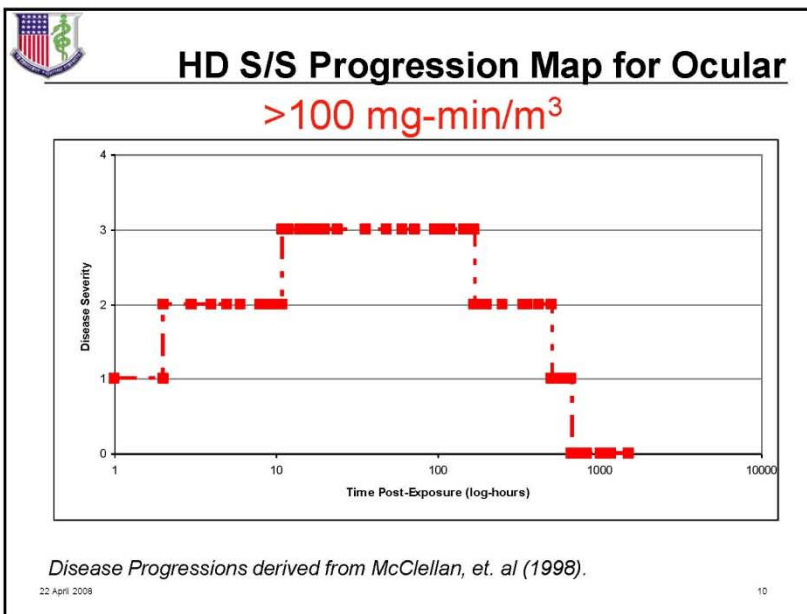
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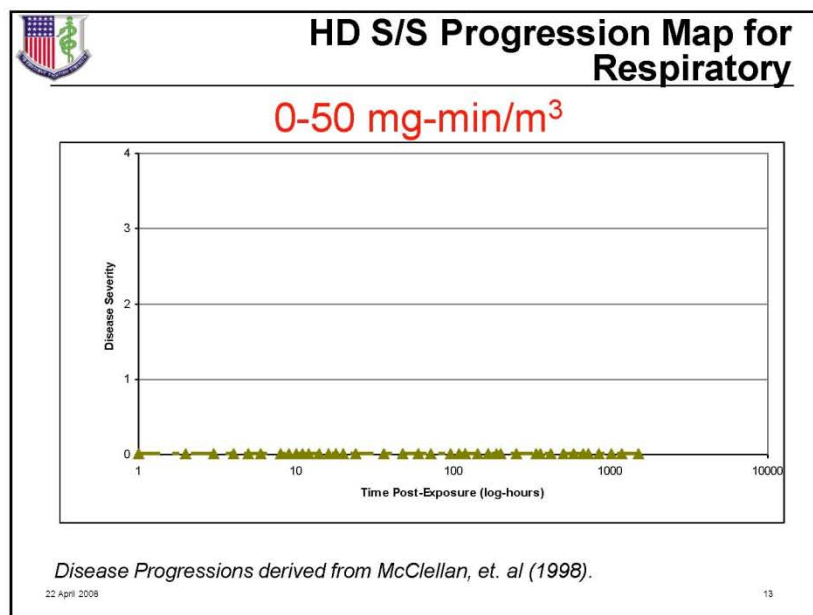
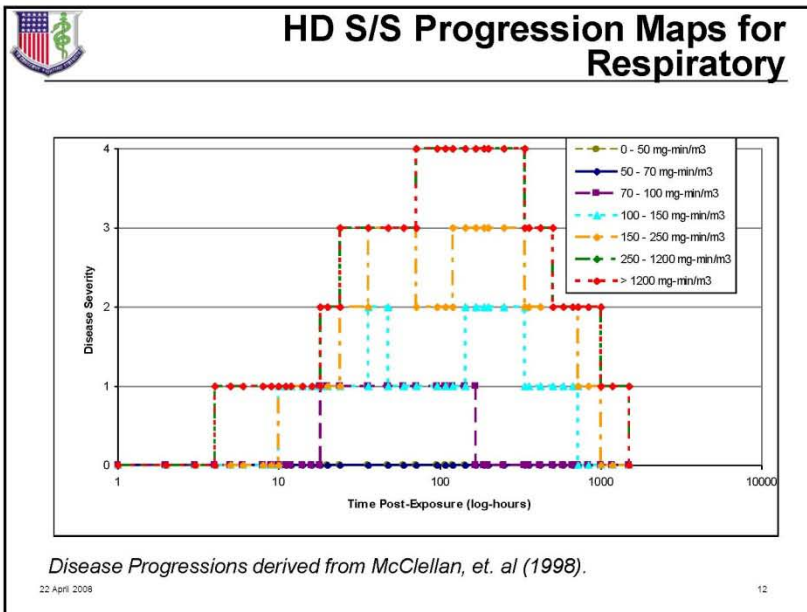


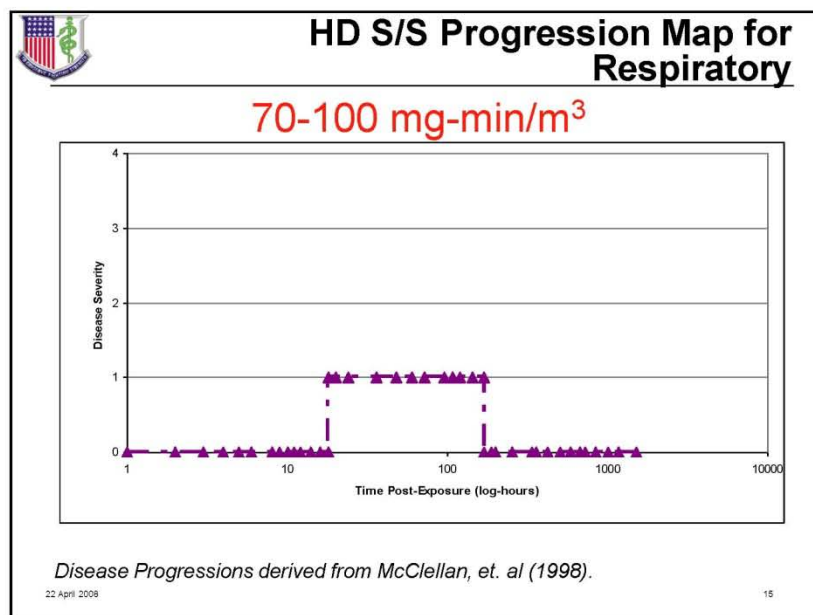
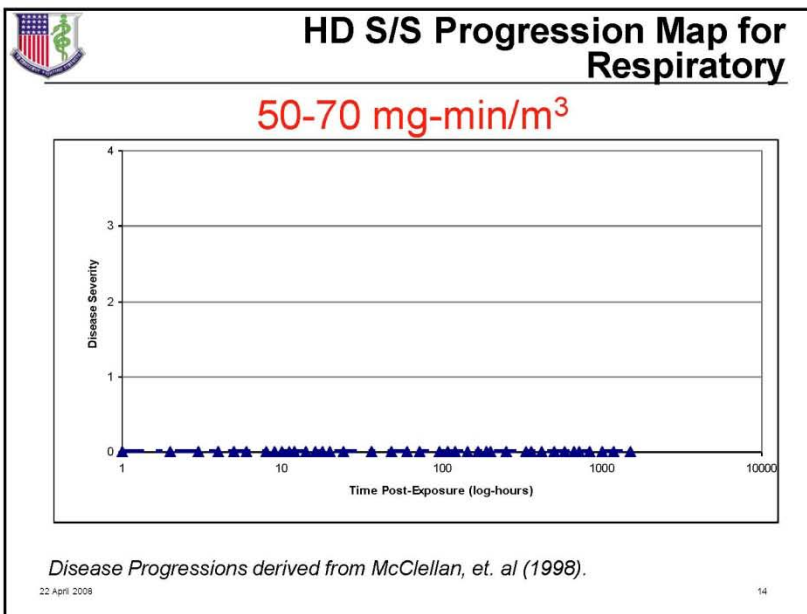


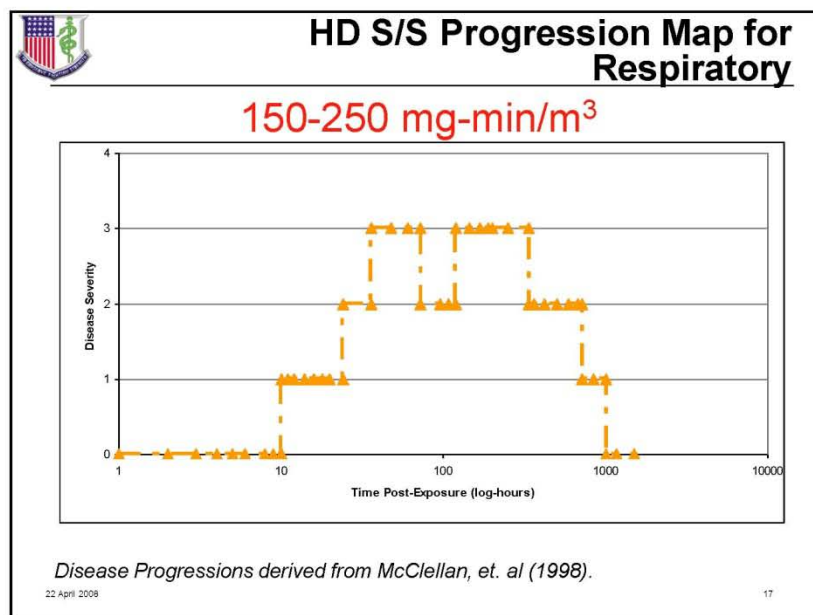
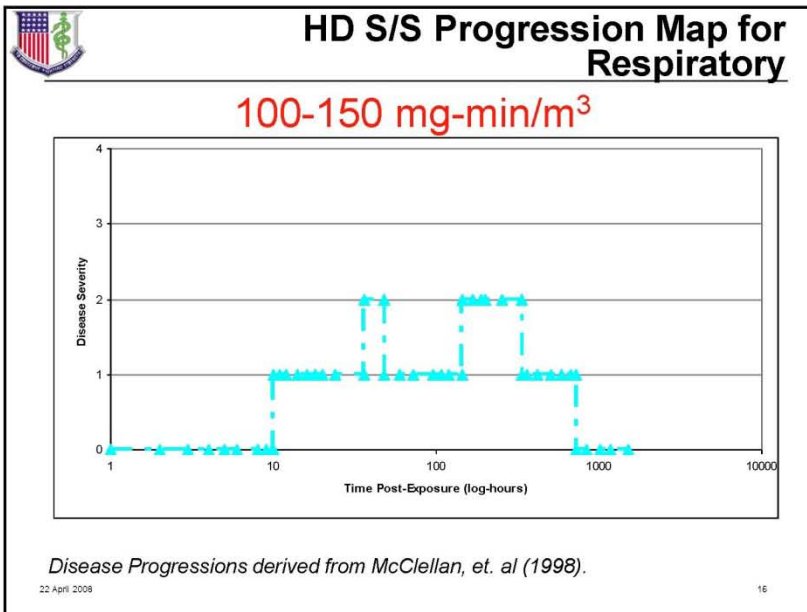
HD S/S Severity

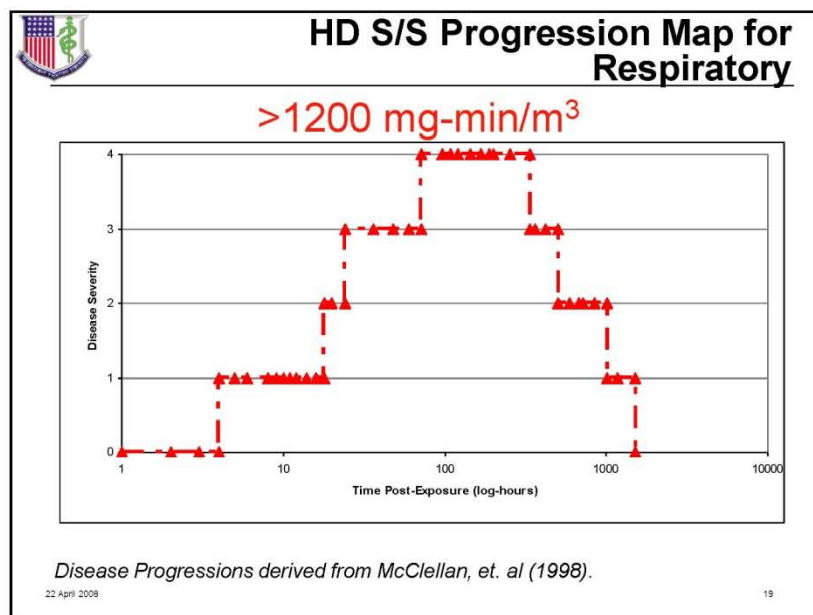
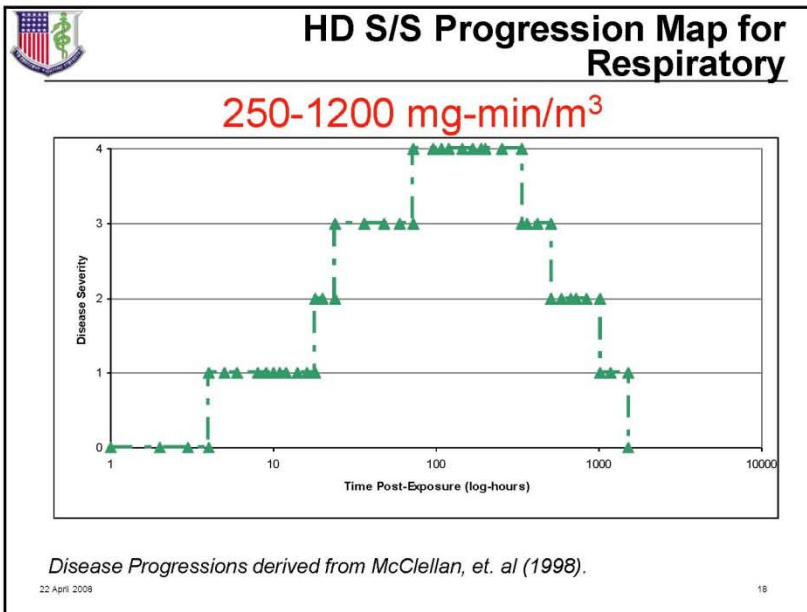
Signs / Symptoms Severity	Respiratory Signs/Symptoms
0	No observable effect
1 Mild	Mild shortness of breath; tight chest, coughing, and runny nose (rhinorrhea)
2 Moderate	Frank shortness of breath; difficult to breathe, wheezing breath, respiratory congestion, bronchorrhea
3 Severe	Breathing sporadically stops and starts, skin has a purple or blue color, hemoptysis
4 Very severe	Breathing stops completely or struggling to breathe; prostration

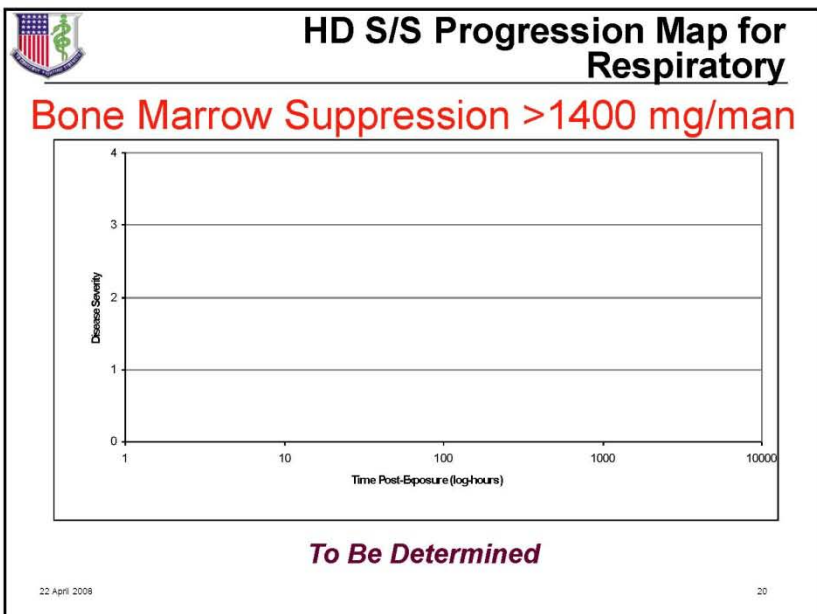
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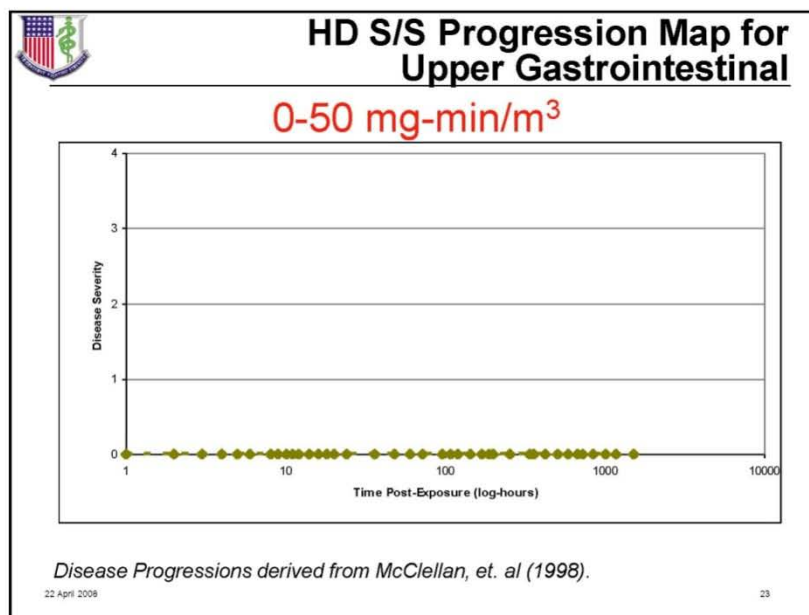
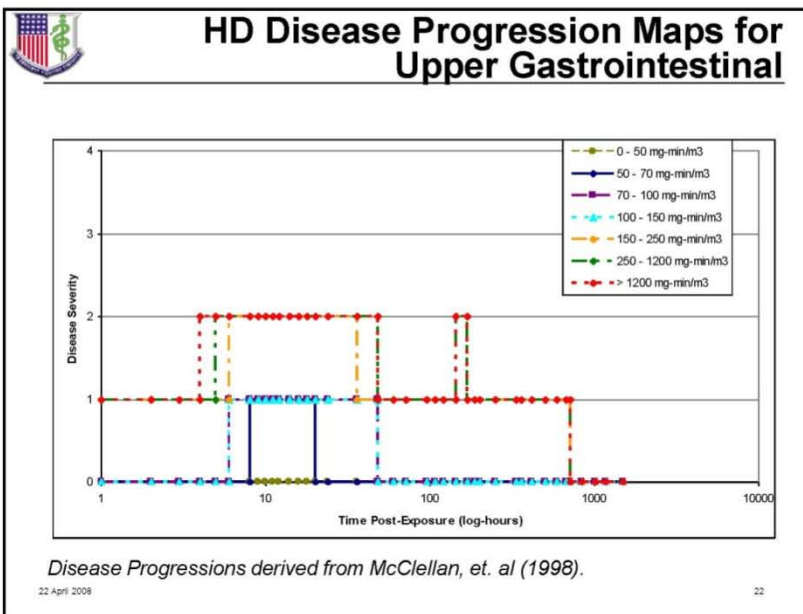


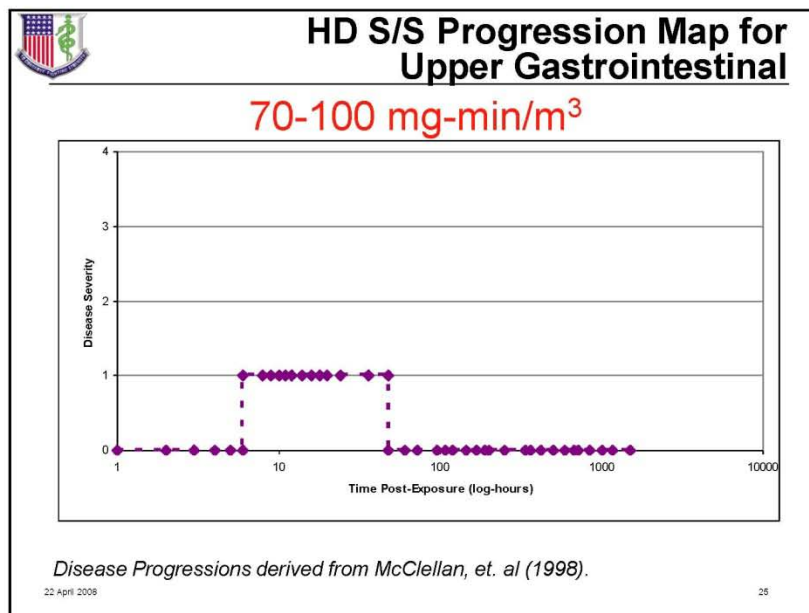
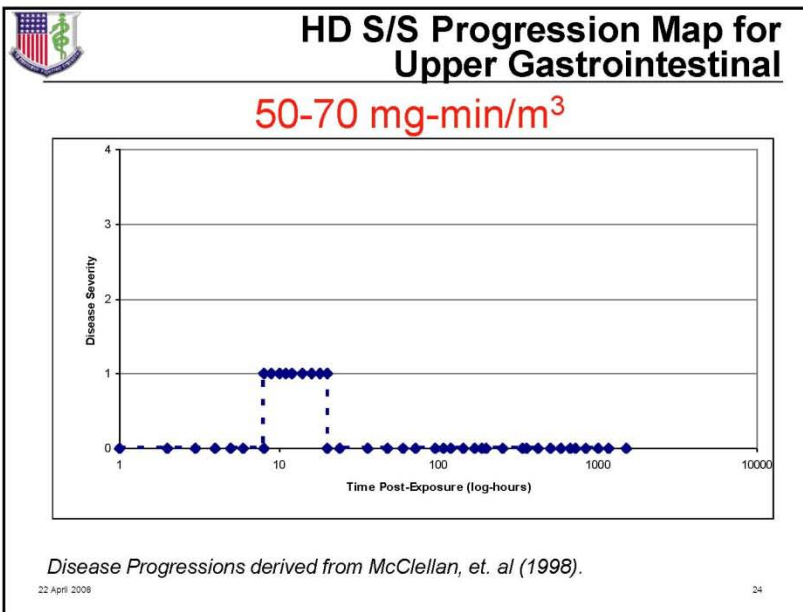


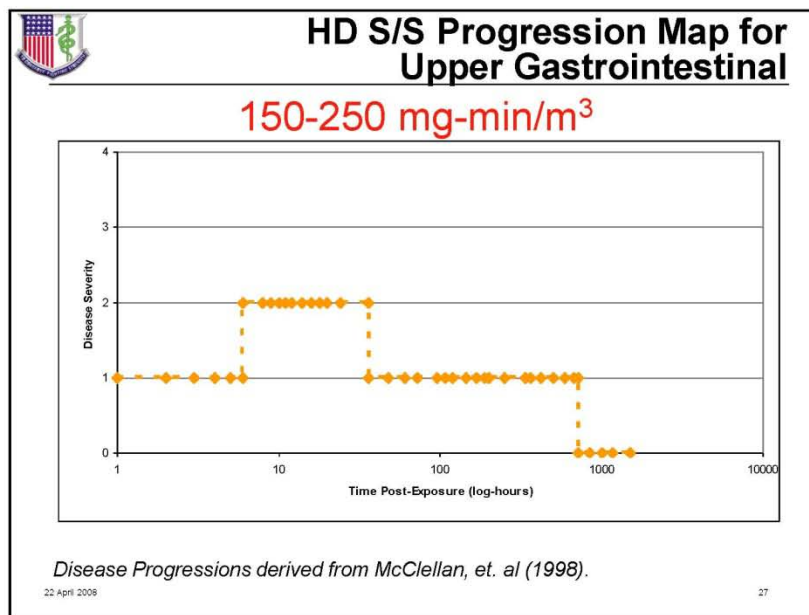
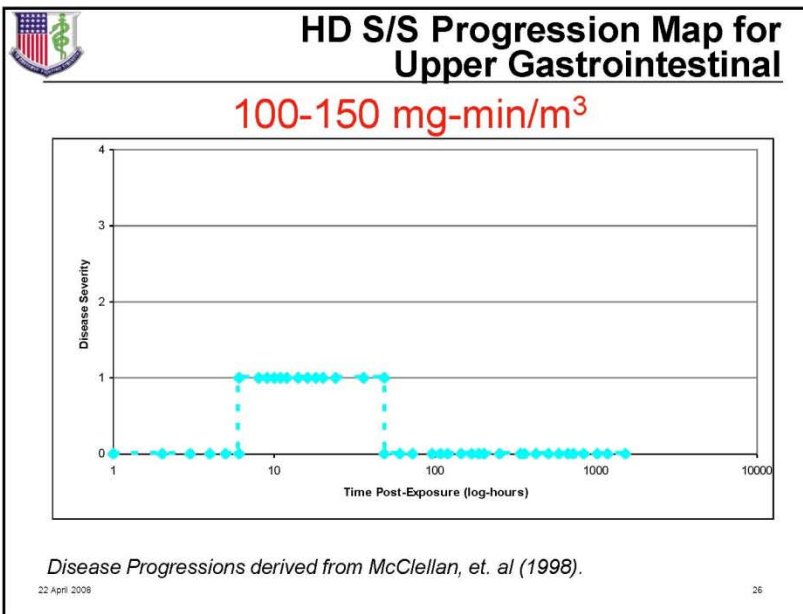
HD S/S Severity

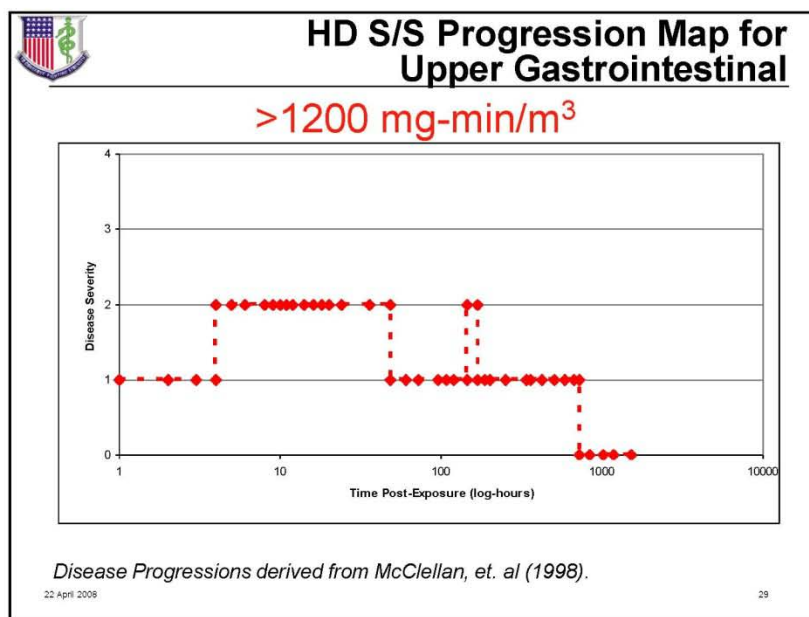
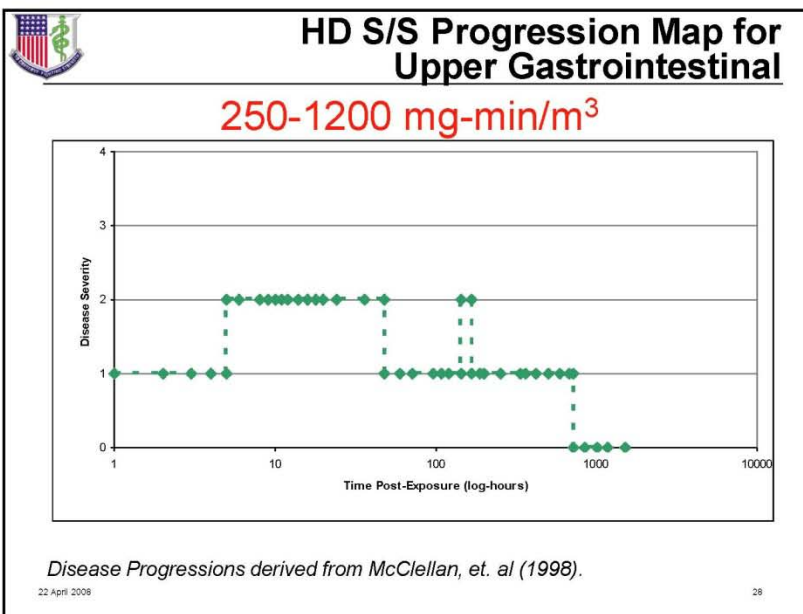
Signs / Symptoms Severity	Upper GI Signs/Symptoms
0	No observable effect
1 Mild	Upset stomach and nausea; watering mouth and frequent swallowing to avoid vomiting
2 Moderate	Episodes of vomiting, possibly including dry heaves; severe nausea and possibility of continued vomiting
3 Severe	
4 Very severe	

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HD S/S Severity

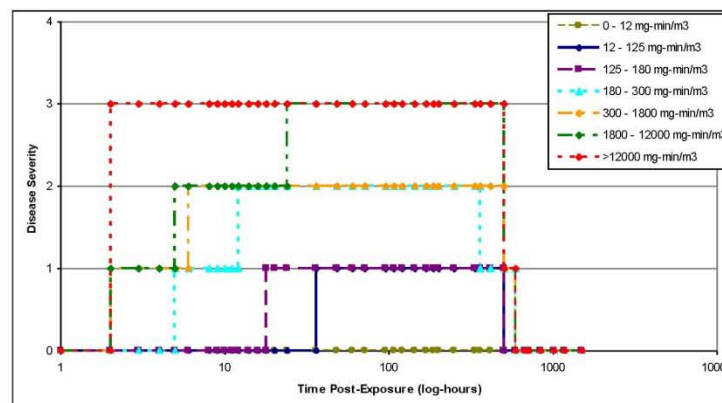
Signs / Symptoms Severity	Skin Signs/Symptoms
0	No observable effect
1 Mild	Itchy skin; skin sensitive to touch in crotch, armpits, and on inside of elbow and knee joints
2 Moderate	Skin sore in crotch, armpits, elbow and knee joints, and painful when moving; red swollen skin, tiny blisters on hands and neck
3 Severe	Possible skin sloughage; large blisters or swollen skin; skin raw and painful in crotch, armpits, elbow and knee joints
4 Very severe	

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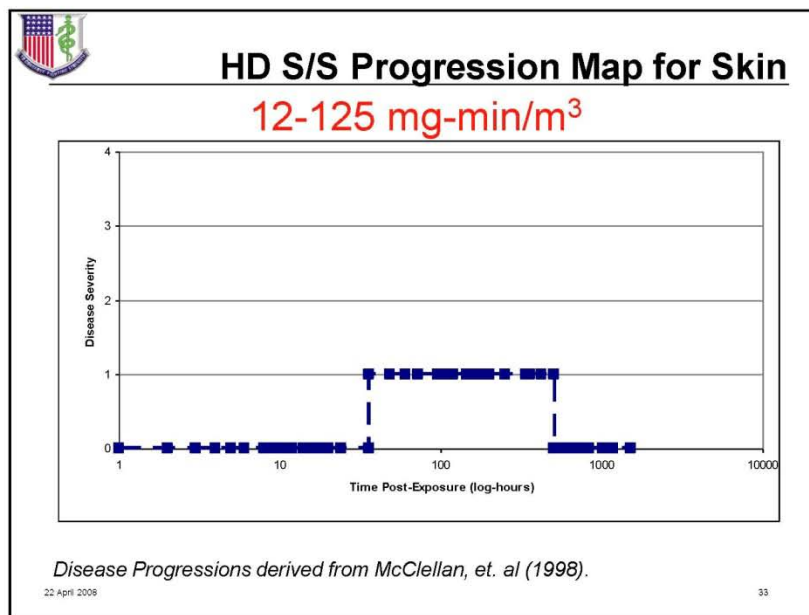
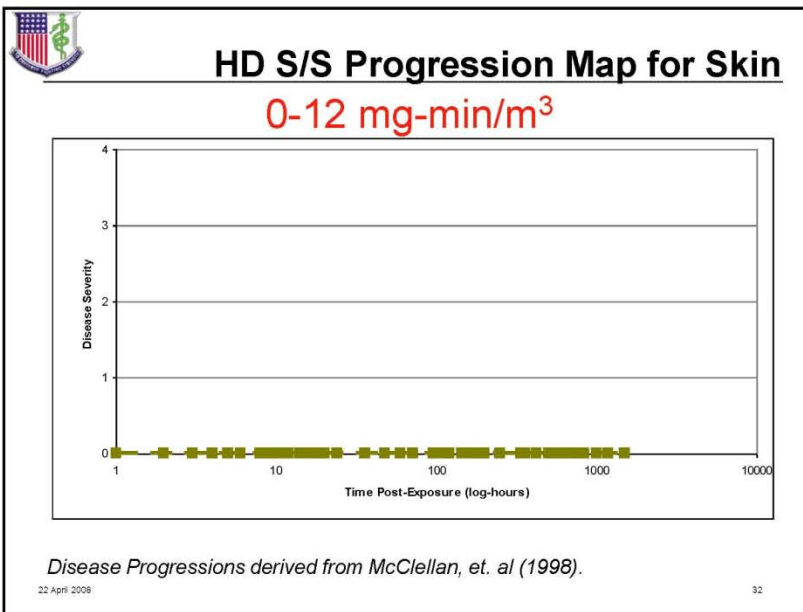
HD Disease Progression Maps for Skin

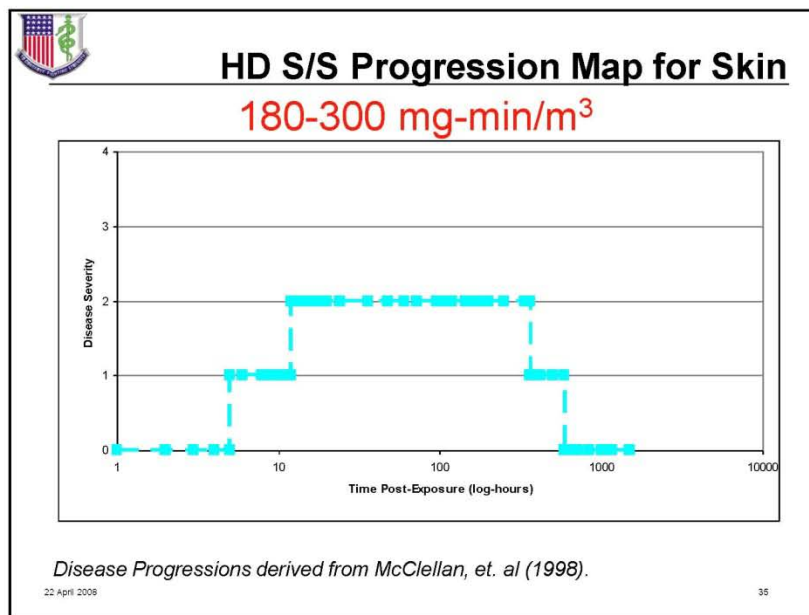
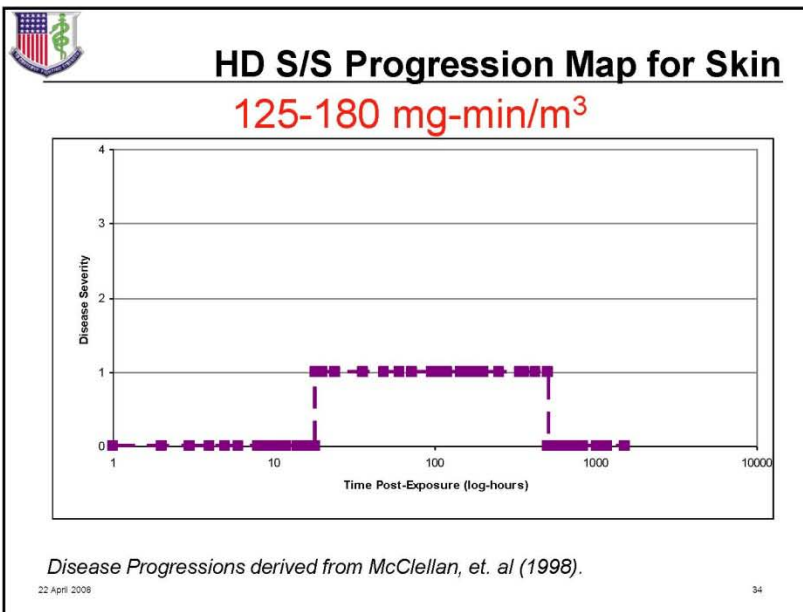


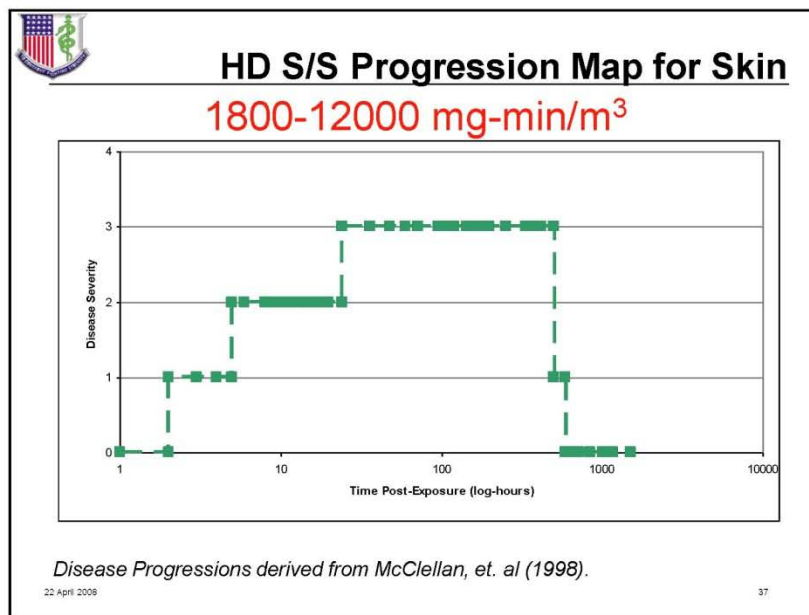
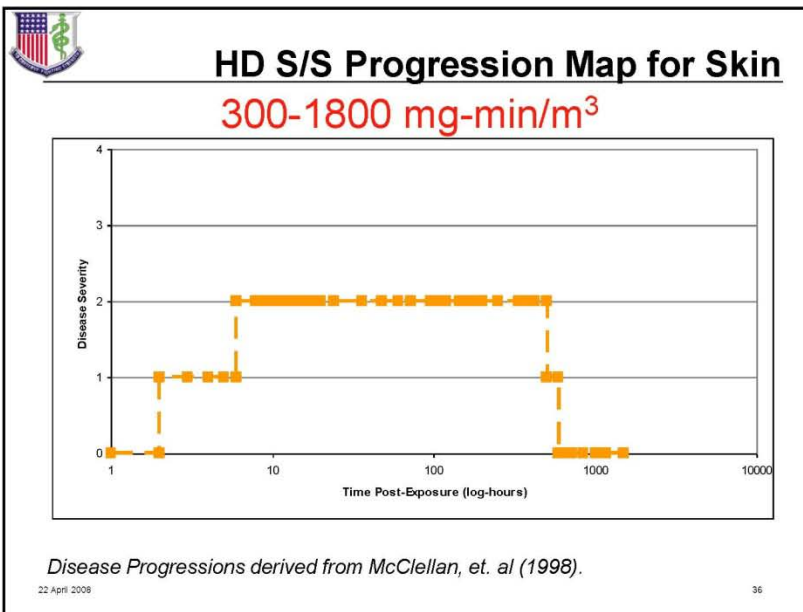
Disease Progressions derived from McClellan, et. al (1998).

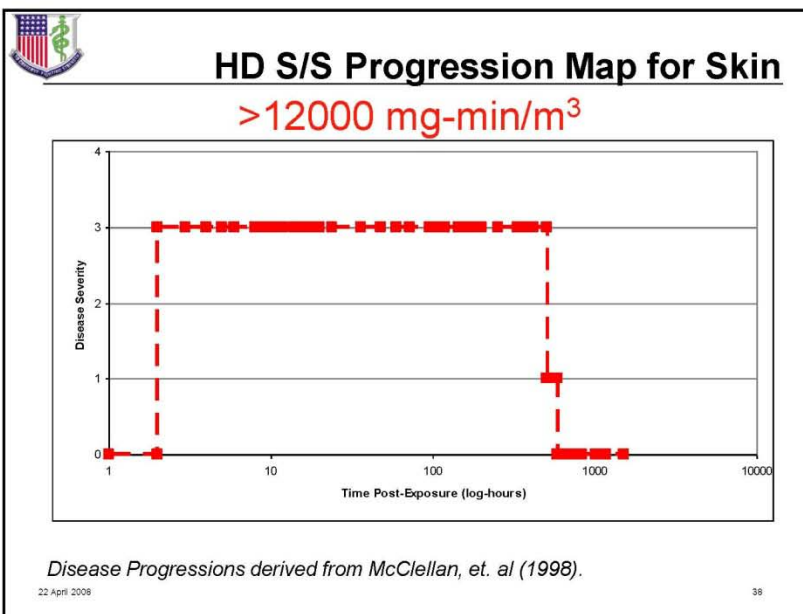
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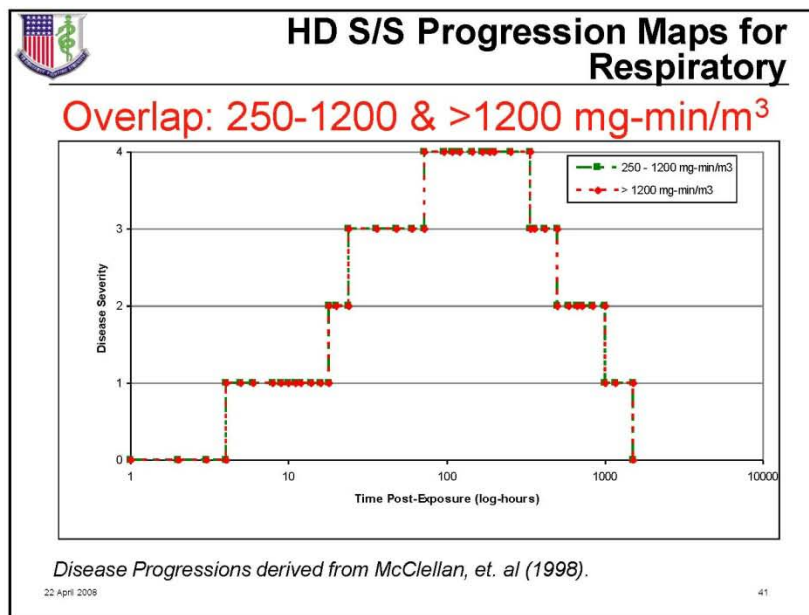
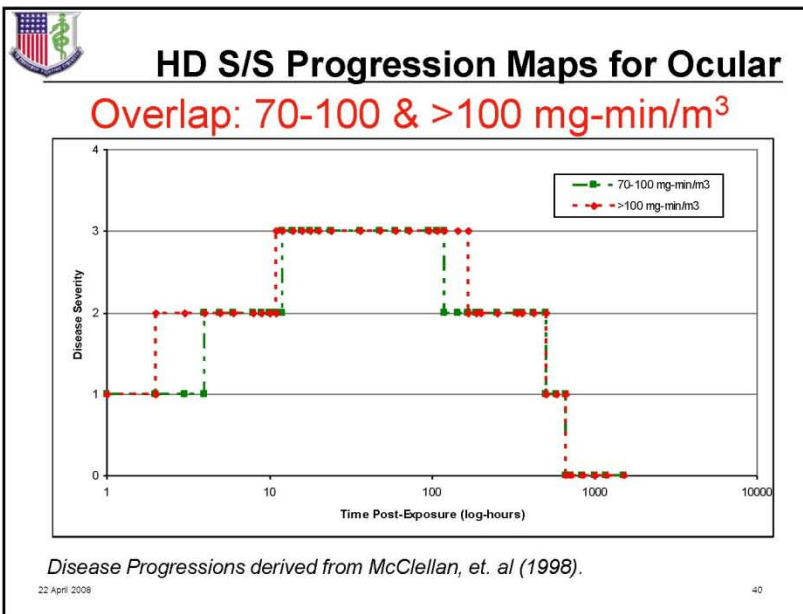


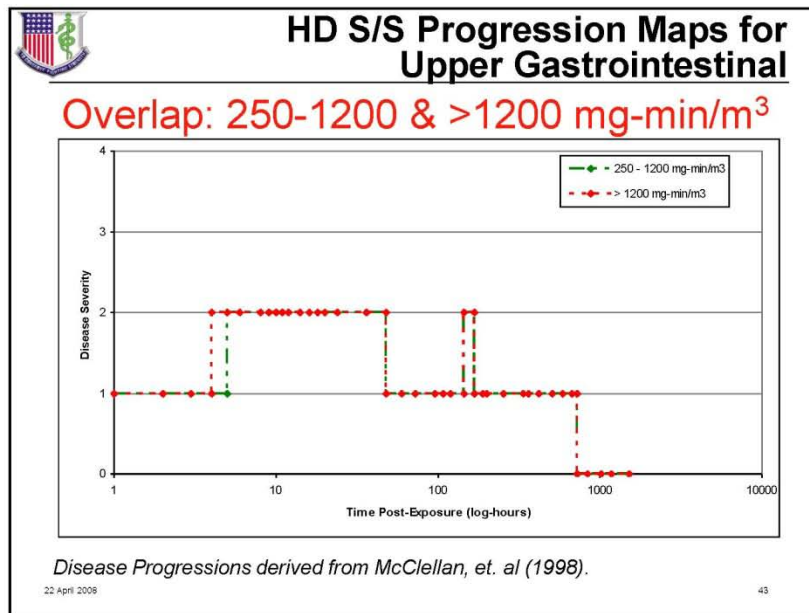
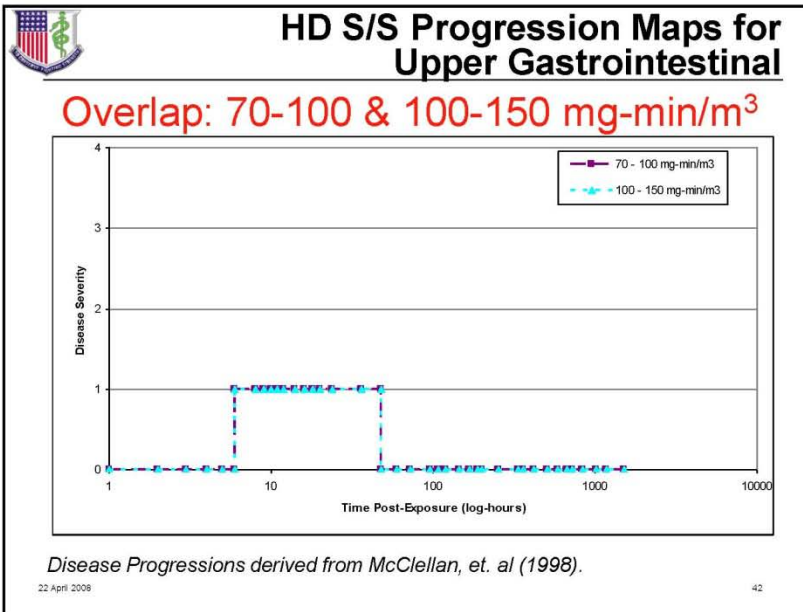




**POSSIBLE HD DOSE RANGE
COLLAPSE**

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Revised Dosage Ranges – HD Ocular

HD Dosage Range (mg-min/m ³)	Description
0 - 4	No observable effect.
4 - 26 26 - 50	Eyes sting, tears, blurred vision; 10% have mild ocular effects at 9 mg-min/m ³ ; 50% at 25 mg-min/m ³ ; 10% have severe ocular effects at 28 mg-min/m ³ .
50 - 70	Eyes feel gritty and sensitive to light, non-stop tears flood eyes; 90% have mild ocular effects at 67 mg-min/m ³ .
> 70	Eyelids are puffy or swollen shut; eyes burn; eyes are too painful to keep open; 50% have severe ocular effects at 75 mg-min/m ³ ; 90% have severe ocular effects at 200 mg-min/m ³ .

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Revised Dosage Ranges – HD Respiratory

HD Dosage Range (mg-min/m ³)	Description
0 – 50	No injury.
50 – 70	Nauseated, swallows often.
70 – 100	Dry mouth, dry cough, sneezing, runny nose, headache, nauseated, vomited once or twice; 10% have severe effects at 80 mg-min/m ³ .
100 - 150	Sore throat, continuous cough, hoarseness, chest feels tight, headache, fever; 50% have severe effects at 135 mg-min/m ³ .
150 - 250	Hurts to breathe, hacking cough, cannot speak, headache, dry heaves, fatigued from vomiting; 90% have severe effects at 230 mg-min/m ³ .
> 250	Awful chest pain, wheezing and shortness of breath, coughs up red colored mucous; 10% die at 600 mg-min/m ³ and 50% mortality at 1000 mg-min/m ³ ; 90% mortality at 1700 mg-min/m ³ .
Dosage Range (mg/man)	Description
> 1400	Very severe effects, including bone marrow suppression due to liquid dosage; >50% lethal effects at 1400 mg/man.

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Revised Dosage Ranges – HD Upper GI

HD Dosage Range (mg-min/m ³)	Description
0 – 50	No injury.
50 – 70	Nauseated, swallows often.
70 – 150	Dry mouth, dry cough, sore throat, sneezing, runny nose, headache, nauseated, vomited once or twice, hoarseness, fever; 10% have severe effects at 80 mg-min/m ³ ; 50% have severe effects at 135 mg-min/m ³ .
150 - 250	Hurts to breathe, hacking cough, cannot speak, headache, dry heaves, fatigued from vomiting; 90% have severe effects at 230 mg-min/m ³ .
> 250	Awful chest pain, wheezing and shortness of breath coughs up red colored mucous; 10% die at 600 mg-min/m ³ and 50% mortality at 1000 mg-min/m ³ ; 90% mortality at 1700 mg-min/m ³ .

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Dosage Ranges – HD skin

HD Equivalent Dosage Range (mg-min/m ³)	Description
0 - 12	No observable effect.
12 - 125	Skin sensitive to touch in tender areas (crotch, armpits, inside of elbow and knee); threshold effects in 10% at 19 mg-min/m ³ , in 50% at 50 mg-min/m ³ .
125 - 180	Skin sore in tender areas; painful when moving; red body skin; tiny blisters on hands and neck; 90% have threshold effects at 134 mg-min/m ³ .
180 - 300	Skin raw and painful tender areas; red, swollen body skin; large blisters on hands and neck; 10% have severe effects at 187 mg-min/m ³ .
300 -1800	Skin peels off leaving open raw areas and painful ulcers in tender areas; 50% have severe body skin effects at 500 mg-min/m ³ ; 90% at 1337 mg-min/m ³ .
1800 - 12000	10% die at 6560 mg-min/m ³ exposure over whole body; 50% die at 10,000 mg-min/m ³ exposure over whole body.
> 12000	90% die at 15,243 mg-min/m ³ exposure over whole body.

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HD DISEASE PROFILE EXAMPLE

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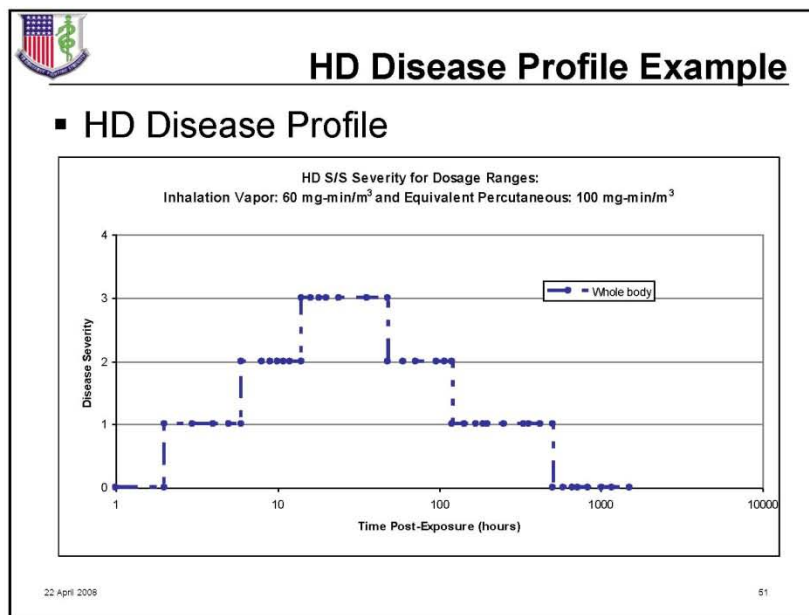
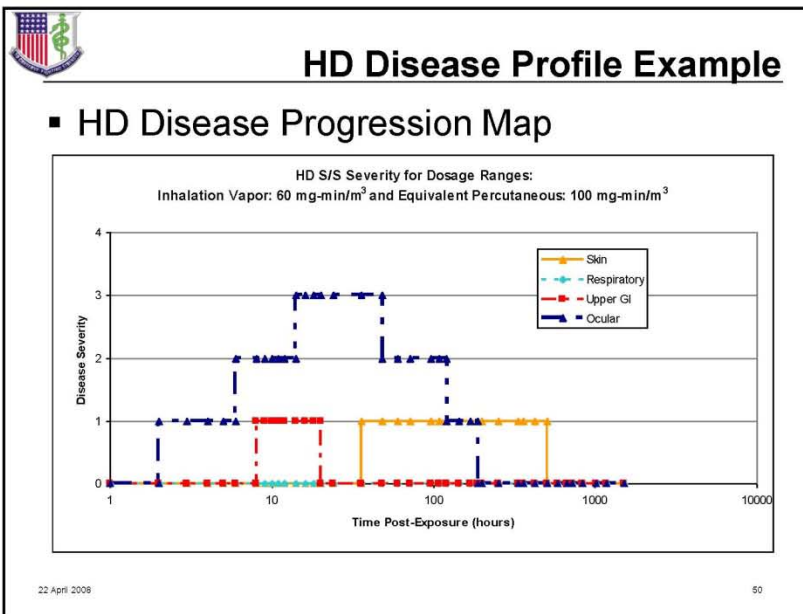


HD Disease Profile Example

- HD Exposure:
 - Ocular & Inhalation Dosage: 60 mg-min/m³
 - Ocular Dosage Range: 50-70 mg-min/m³
 - Respiratory & Upper GI Dosage Range: 50-70 mg-min/m³
 - Skin Equivalent Dosage: 100 mg-min/m³
 - Skin Equivalent Dosage Range: 12-125 mg-min/m³

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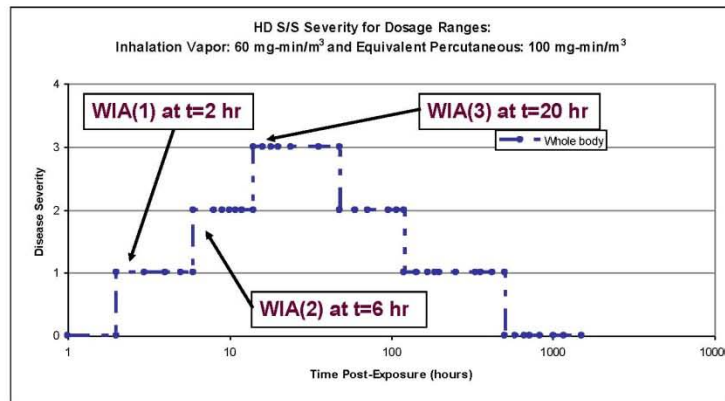
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HD Disease Profile Example

■ HD Disease Profile



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Subject Matter Expert Meeting – Chemical Human Response Models

Questions?



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H. Chemical Agent Casualty Profiles – *Briefing*




Allied Medical Publication 8 (AMedP-8) SD.3 2008
Medical Planning Guide for CBRN Casualty Estimation
Subject Matter Expert Meeting – Chemical Human Response Models

***AMedP-8(C) NATO Planning Guide for the
Estimation of CBRN Casualties***

**Chemical Agent Casualty
Profiles**

Carl A. Curling
Deena Disraelly
Robert Zirkle
Institute for Defense Analyses
22 April 2008



Casualty Rate Estimation

- The required outputs of the Casualty Rate Estimation Process (per AJP 4-10.1) are:
 - Population at Risk (PAR)
 - Rates – number of casualties/100/day (AJP 4-10)
 - [Scenario] Profile
 - Rate behaviour - pulses and pauses - and their variability over the full force and time (AJP 4-10)
 - Severity and patterns of casualties to be expected (AJP 4-10.1)
 - Flow – movement of casualties through the medical system (AJP 4-10)

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AMedP-8 Human Response Models

The proposed Human Response Models:

- Estimates the status over time of personnel exposed to some Chemical, Biological, Radiological, or Nuclear agent or effect
- Allow for estimation of:
 - KIA as a function of specific levels of effect
 - WIA at the time at which signs, symptoms and/or illness reach a specified severity level or as a function of specific effect levels
 - DOW at some time after agent or effect exposure as a function of an agent/effect-related estimation or a specified severity level
- Also allow for a description of effects or "illness" severities over time

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CASUALTY RATE ESTIMATOR OUTPUTS CHARACTERIZATION

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[Scenario] Profile

- A. Casualty Type
- KIA, WIA, DOW

Amplifying WIA Information:

- B. Injury or Disease Severity**
- **Mild, Moderate, Severe, Very Severe at organism level**
- C. System
- Upper GI, Lower GI, Skin, Respiratory, Muscular, Cognitive
- D. System Severity
- Mild, Moderate, Severe, Very Severe for each of:
 - Upper GI, Lower GI, Skin, Respiratory, Muscular, Cognitive
- E. Sign / Symptom Description
- Vomiting, Muscle Twitching, Functional Blindness, ...

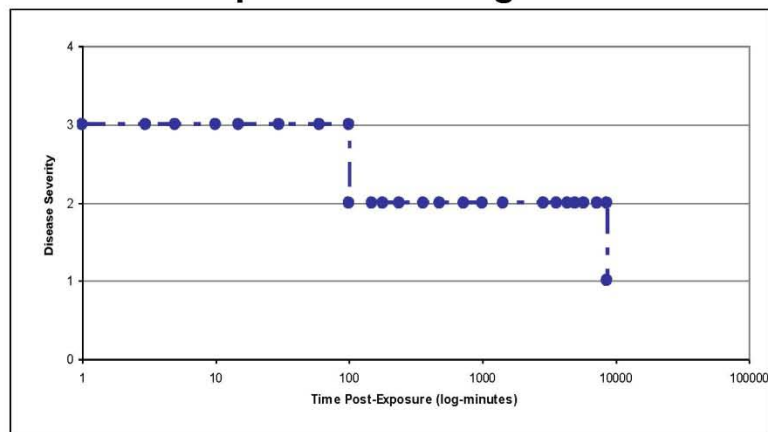
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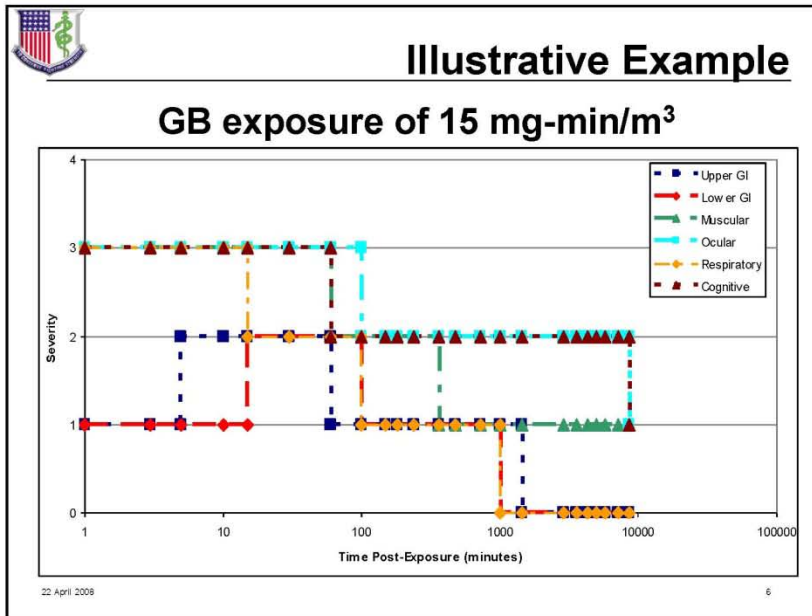
Illustrative Example


GB exposure of 15 mg-min/m³



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-  **Illustrative Example [Scenario] Profile**
- A. Casualty Type
 - WIA
 - B. Injury or Disease Severity
 - **Severe Nerve Agent WIA**
 - C. Systems
 - WIA with cognitive, ocular, respiratory, muscular, upper and lower gastrointestinal signs and symptoms
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Illustrative Example [Scenario] Profile

D. System Severity

- Immediately Post Exposure:
 - WIA with Severe cognitive, ocular, respiratory, and muscular signs and symptoms, with Mild upper and lower gastrointestinal signs and symptoms
- 30 minutes Post Exposure:
 - WIA with Severe cognitive, ocular, and muscular, Moderate respiratory and upper gastrointestinal signs and symptoms, with Mild lower gastrointestinal signs and symptoms
- 1 hour Post Exposure:
 - WIA with Severe ocular, Moderate cognitive, respiratory muscular, and lower gastrointestinal signs and symptoms, with Mild upper gastrointestinal signs and symptoms

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Illustrative Example [Scenario] Profile

E. Sign / Symptom Description

- 30 min Post Exposure:
 - Aphasia; memory loss; disorientation
 - Functional blindness (possibly accompanied by extreme headache)
 - Severe generalized trembling with or without convulsions
 - Frank shortness of breath; difficult to breathe, wheezing breath, respiratory congestion, bronchorrhea
 - Episodes of vomiting, possibly including dry heaves; severe nausea and possibility of continued vomiting
 - Abdominal pain or cramps; occasional diarrhea and uncomfortable urge to defecate

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Recommendation

[Scenario] Profile: The description of CBRN casualties by type, and for WIA; severity and disease or injury type. For example: KIA, WIA Severe Nerve, WIA Mild Blister,

...

Provides information on operational status for the operational planner and injury types for the medical planner

- Time personnel are lost to unit
- Type of injury and implied medical requirement

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RECOMMENDED VALUES

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Recommended Casualty Definitions

AAP-6 Definitions:

- WIA - "In relation to personnel, any person who is lost to his organization by reason of having been declared dead, wounded, diseased, detained, captured or missing."
- DOW - "A battle casualty who dies of wounds or other injuries received in action, after having reached a medical treatment facility."
- KIA - "A battle casualty who is killed outright or who dies as a result of wounds or other injuries before reaching a medical treatment facility."

Model Implementation:

- WIA - Individual whose disease profile severity ≥ 1
- DOW - Individual whose disease profile severity ≥ 4 for 15 minutes or 2 consecutive reporting times (whichever is longer)
- KIA - Individual who meets the criteria for DOW before reaching a medical treatment facility (appr. 30 minutes post-release)

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Subject Matter Expert Meeting – Chemical Human Response Models

Questions?



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I. Review, Conclusions, and Way Ahead – *Briefing*




Allied Medical Publication 8 (AMedP-8) SD.3 2008
Medical Planning Guide for CBRN Casualty Estimation
Subject Matter Expert Meeting – Chemical Human Response Models

***AMedP-8(C) NATO Planning Guide for the
Estimation of CBRN Casualties***

**Review, Conclusions, and Way
Ahead**

MAJ Kevin Hart
US Army
Office of the Surgeon General
22 April 2008



Meeting Objective

- To develop agreement within NATO on:
 - The proposed concept for modeling human response to chemical agents in AMedP-8
 - Chemical toxicity data used in the models
 - Outputs of the model
 - Numbers of KIA, WIA, DOW over time
 - Disease severity over time for WIA
 - SD.3 objectives and desired outputs

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Concurrence

- General modeling concept – human response can be estimated using specified severity levels as occur on disease profiles
 - GB & HD progressions are approved with noted changes
 - VX inhalation progressions follow GB inhalation progressions
 - VX percutaneous liquid progressions will be drawn
- Medical countermeasures and medical treatment are not considered
- Signs and Symptoms levels are descriptive with discussed changes
 - Split ocular and respiratory signs and symptoms to represent GB/VX and HD separately
 - GB/VX Cognitive changes to Neurological and incorporates seizures and prolonged seizures
 - HD Skin order of temporal description in “very severe” changes

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Concurrence (continued)

- Proposed toxicity values and resultant dosage ranges
 - Further investigation of GB miosis effective median toxicity value may be required
 - Resulting dosage ranges are acceptable with changes to descriptions as discussed
 - Change “Mild Respiratory Effects” to “Rhinnorhea”
 - Add “Shock-like syndrome” to Respiratory dosage range 8
- Recommended values for severity & time associated with KIA, WIA & DOW

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Additional Tasks

- Nations – provide supporting documentation, studies, & references as available
 - Toxicity values and probit slopes
 - Signs & symptoms progressions
- US –
 - VX Percutaneous Liquid maps will be proposed for review by the Nations
 - Changes to GB/VX inhalation maps and HD maps as discussed
 - Changes to signs & symptoms descriptions as discussed
 - Changes to dosage range descriptions as discussed
 - Several topics will be noted as model limitations and addressed in the text of SD.3:
 - Cardiovascular effects resulting from nerve agent exposure
 - Hematopoietic syndrome effects resulting from HD exposure
 - Signs & symptoms descriptions reflect the ascension of illness; recovery phase of illness is not explicitly described

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AMedP-8(C) Study Timeline

- SD.3 (Describe algorithms and required parameters for human response models)
 - Custodial Meetings--review technical aspects of modeling human response with national Subject Matter Experts
 - **21-22 April 2008, Chemical agents (Munich, in conjunction with German Medical Chemical Conference)**
 - 8-9 May 2008, Biological agents (San Lorenzo de El Escorial, in conjunction with 21st BioMedAC)
 - 23-27 June 2008, Nuclear effects & Radiological agents (Albuquerque, New Mexico)
 - September 2008, "Virtual Custodial Meeting" for final pre-coordination review of CBRN casualty estimation (by correspondence)
 - November 2008, Publish SD.3 for review
 - February 2009, Custodial Meeting in conjunction with CBRNMedWG Meeting to adjudicate SD.3 comments and discuss input to NATO conventional casualty estimation tools (Brussels)

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Medical Planning Guide for CBRN Casualty Estimation
Subject Matter Expert Meeting – Chemical Human Response Models

Questions?



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REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
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1. REPORT DATE (DD-MM-YY) August 2009		2. REPORT TYPE Final		3. DATES COVERED (From - To)	
4. TITLE AND SUBTITLE Proceedings of the NATO Chemical Human Response Subject Matter Expert Review Meeting, 21-22 April 2008, Munich Germany				5a. CONTRACT NO. DASW01-04-C-0003	
				5b. GRANT NO.	
				5c. PROGRAM ELEMENT NO(S).	
6. AUTHOR(S) Julia K. Burr, Carl A. Curling, Deena S. Disraelly, Preston J. Lee, Terri J. Walsh, Robert A. Zirkle				5d. PROJECT NO.	
				5e. TASK NO. CA-6-2281	
				5f. WORK UNIT NO.	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Institute for Defense Analyses 4850 Mark Center Drive Alexandria, VA 22311-1882				8. PERFORMING ORGANIZATION REPORT NO. IDA Document D-3883	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Office of the Army Surgeon General ATTN: DASG-HCO (MCOP-P) 5111 Leesburg Pike, Suite 401A Falls Church, VA 22041-3258				10. SPONSOR'S / MONITOR'S ACRONYM(S) OTSG	
				11. SPONSOR'S / MONITOR'S REPORT NO(S).	
12. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution unlimited.					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT In April 2008, NATO subject matter experts met in Munich, Germany to discuss an approach to modeling human response and casualty estimation for incorporation into NATO Allied Medical Publication 8, <i>NATO Planning Guide for the Estimation of CBRN Casualties</i> . The purpose of this two-day conference was to review the proposed human response model for estimating casualties resulting from exposure to chemical agents—sarin (GB), VX, and chemical mustard (HD)—focusing in particular on severity definitions and the dose-based injury profiles for these three agents. During the conference, participants reached consensus on the chemical human response model and the injury profiles for use in the document. The presentations and consensus points reached during the NATO Chemical Human Response Subject Matter Expert Review Conference are summarized herein. This conference was sponsored by the US Army Office of the Surgeon General (OTSG).					
15. SUBJECT TERMS Modeling, human response, casualty estimation, chemical warfare, sarin, GB, VX, chemical mustard, HD					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NO. OF PAGES 232	19a. NAME OF RESPONSIBLE PERSON LTC Craig Moss, USA
a. REPORT U	b. ABSTRACT U	c. THIS PAGE U			19b. TELEPHONE NUMBER (Include Area Code)

